Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 1

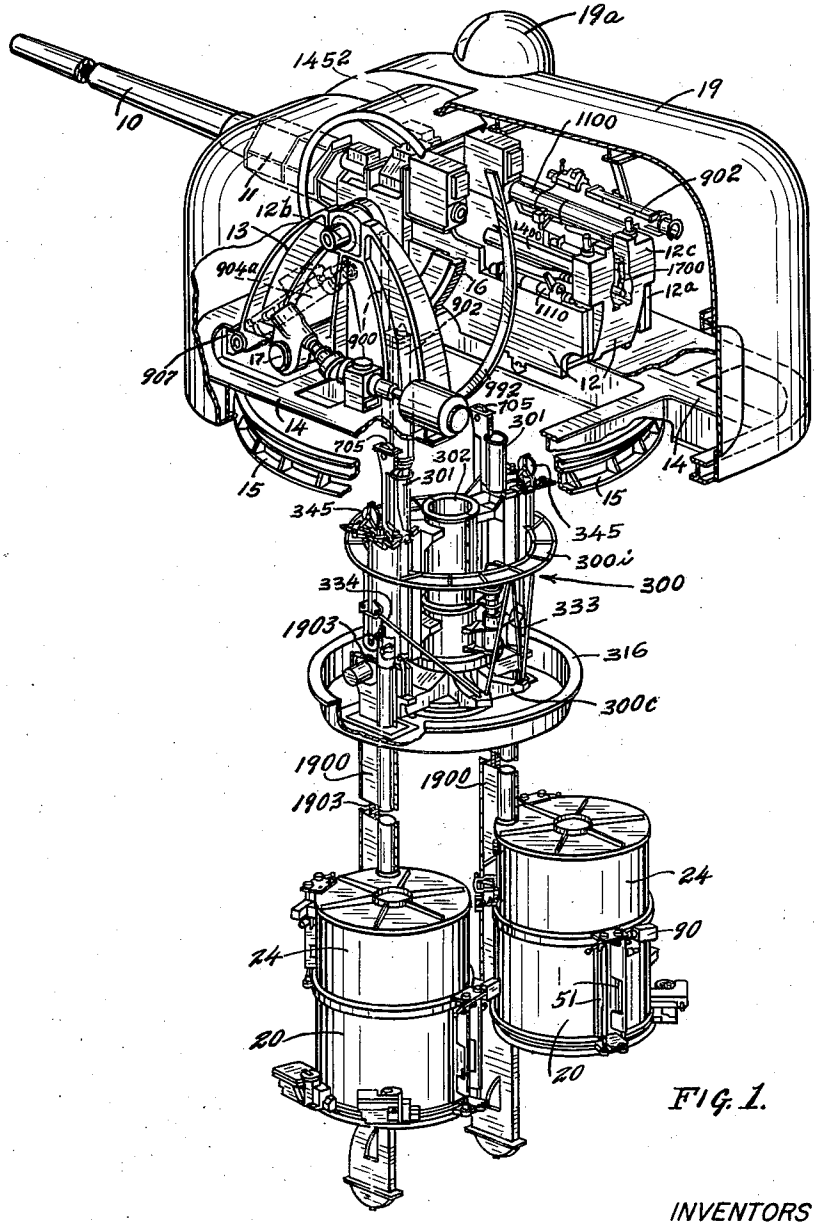

FIG. 1.

INVENTORS

PHILIAS H. GIROUARD,
CARL V. HICKMAN, DECEASED,
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MILTON C. NEUMAN,
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THOMAS C. COLLIER

By R. D. O'Brien & R. M. Hicks ATTYS

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 2

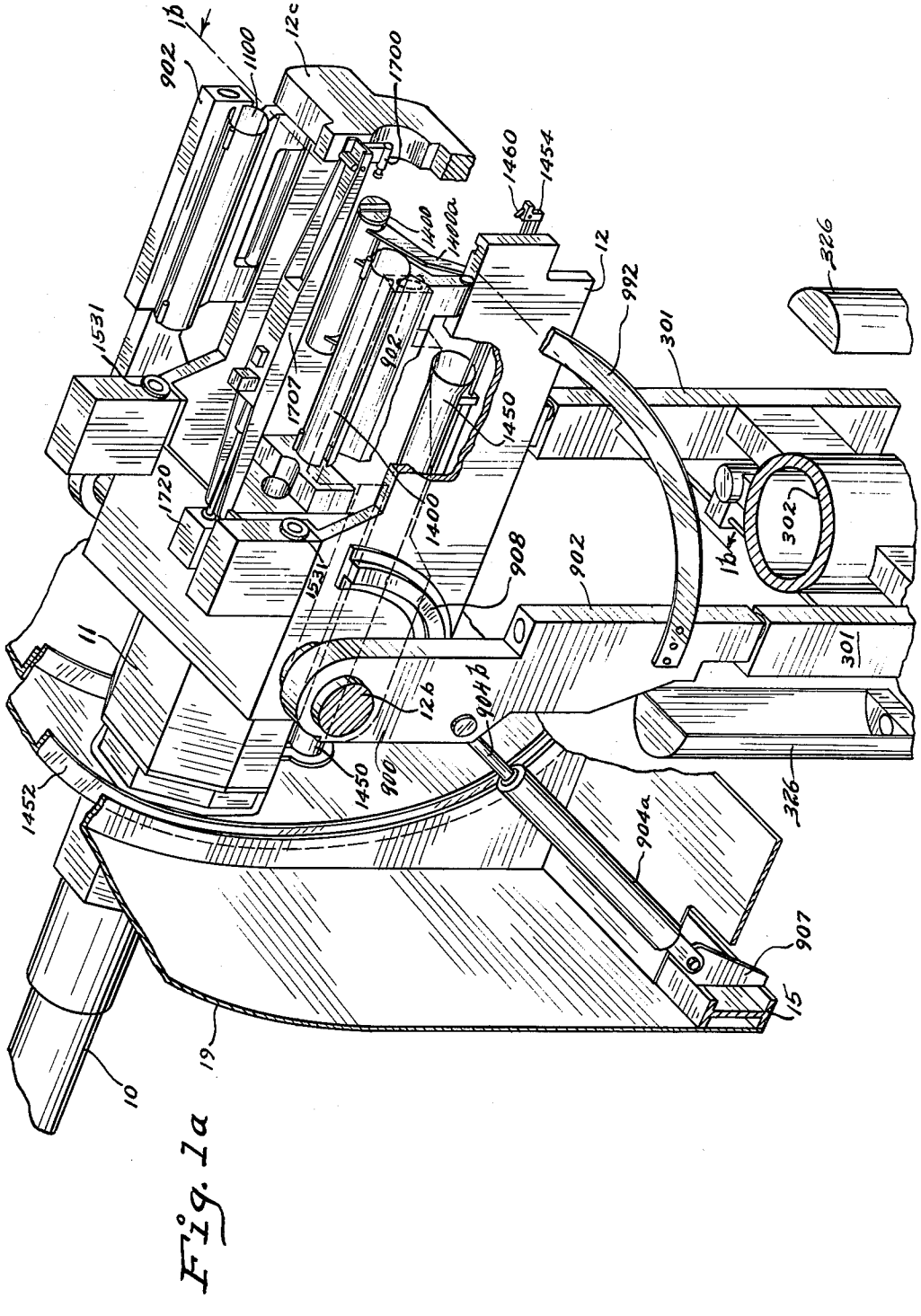


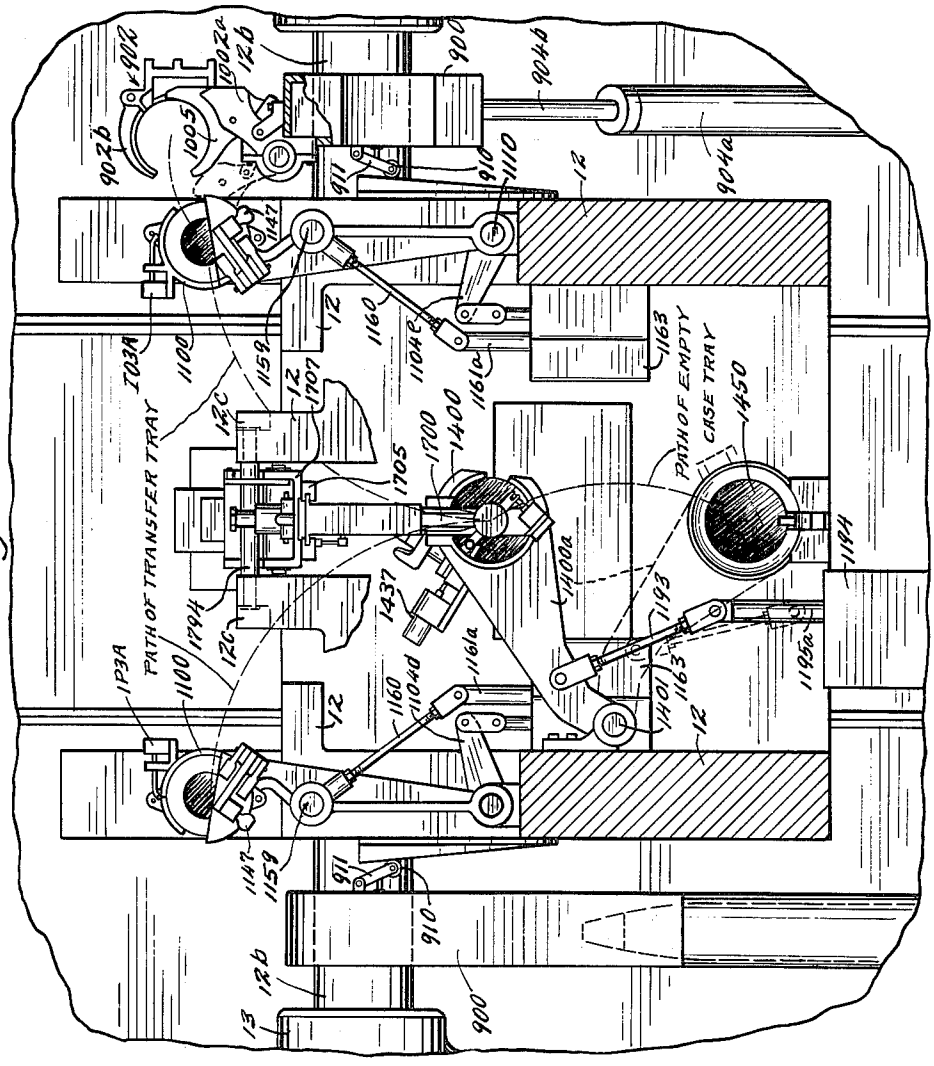
Fig. 1a

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 3

Fig. 1b.



GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 4

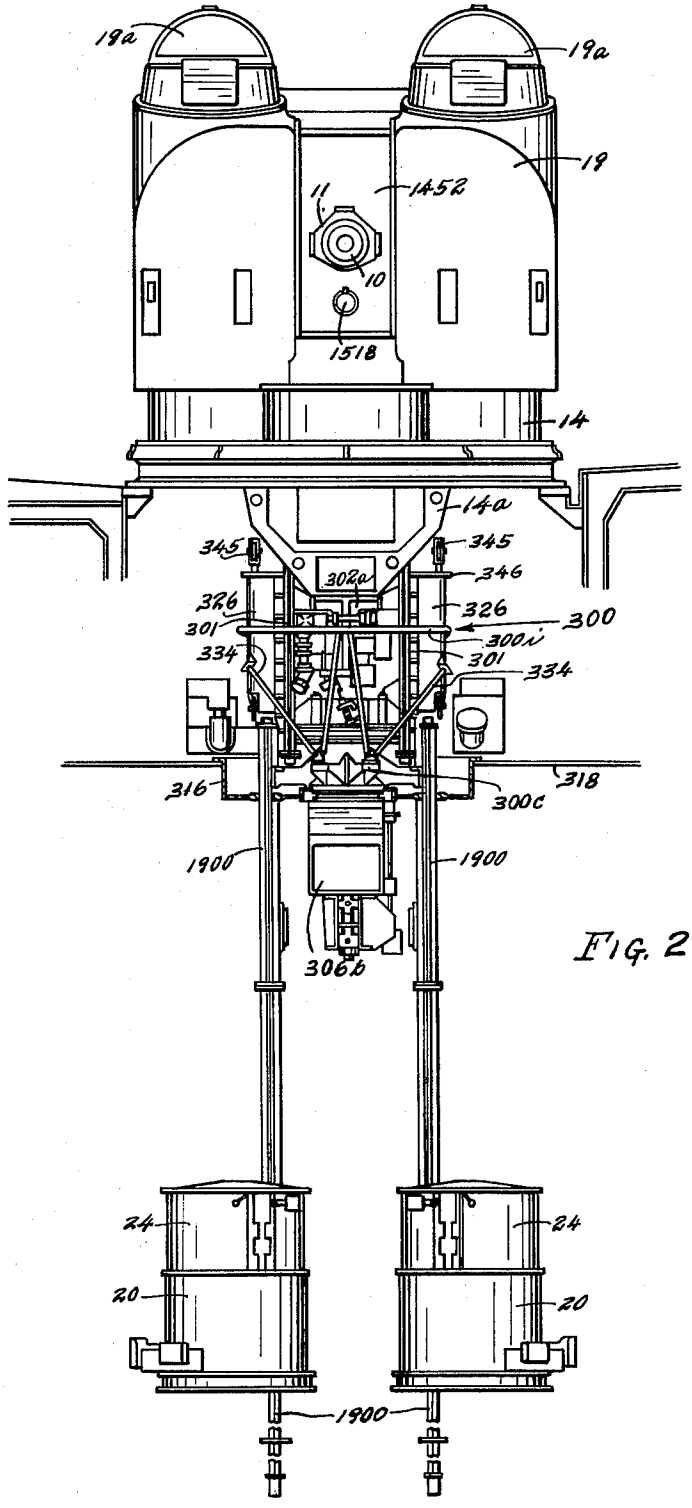


FIG. 2

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 5

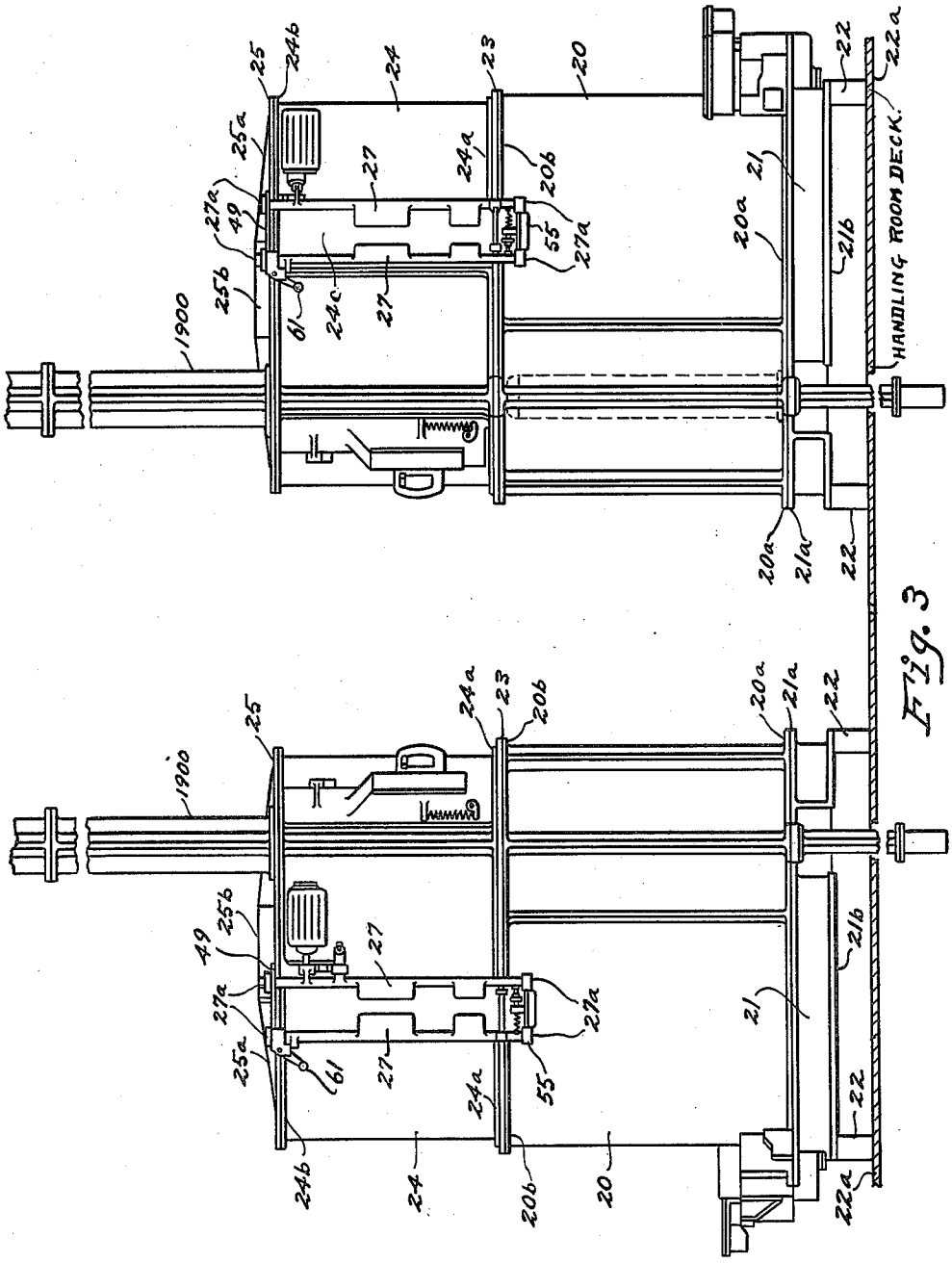


FIG. 3

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 6

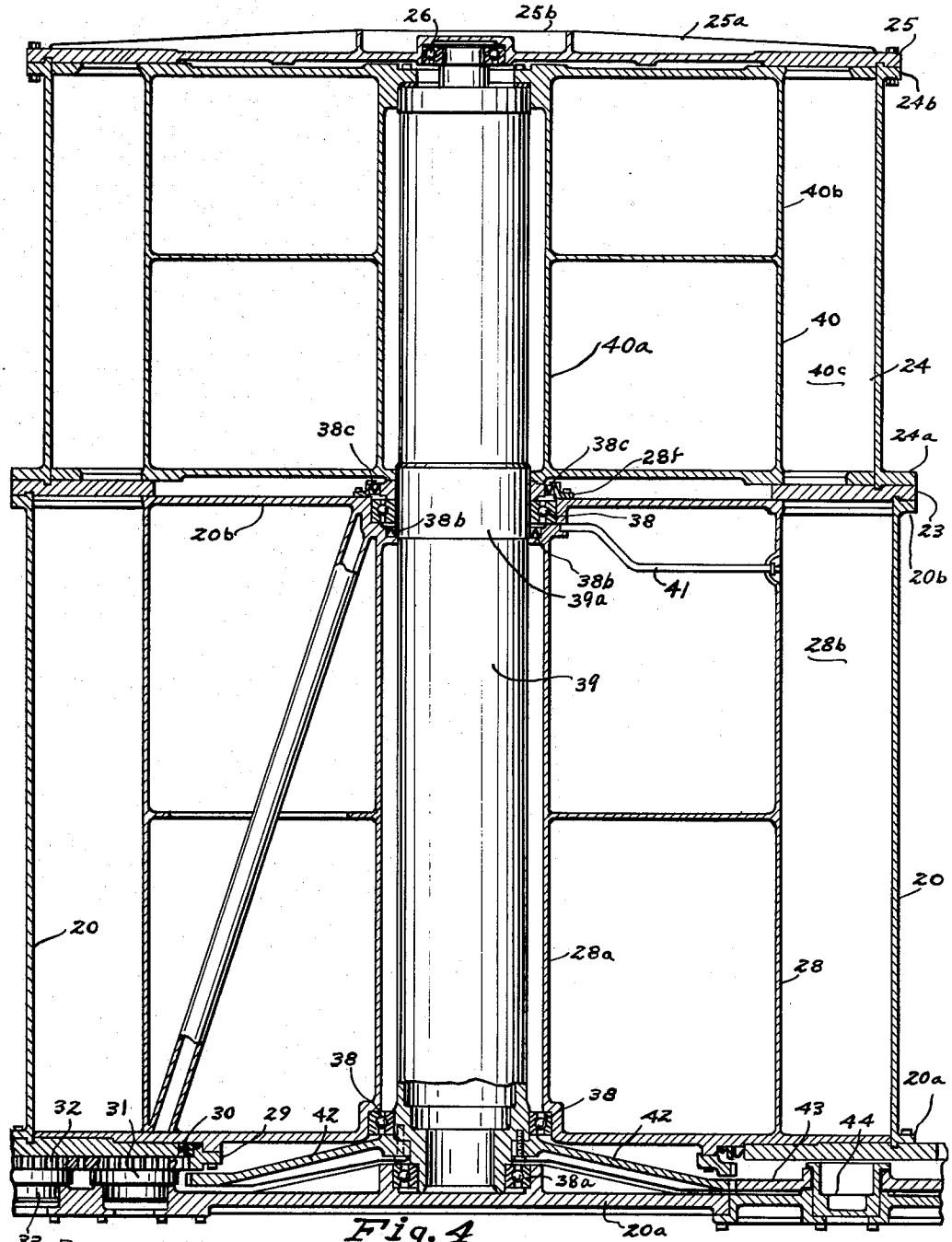


Fig. 4

Fig. 5

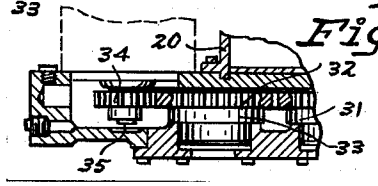
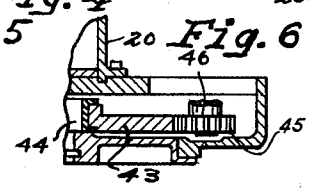


Fig. 6



Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 7

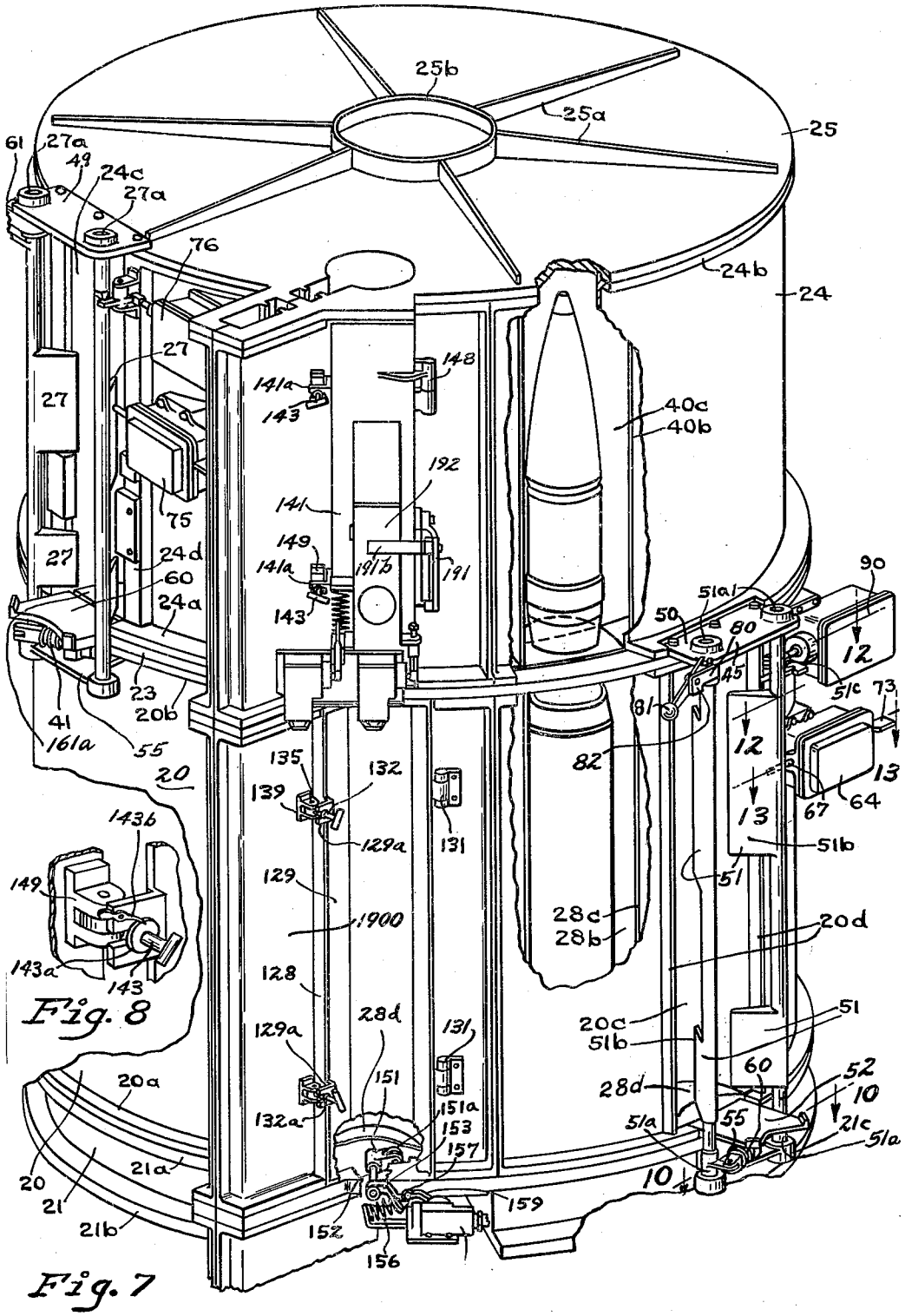


Fig. 8

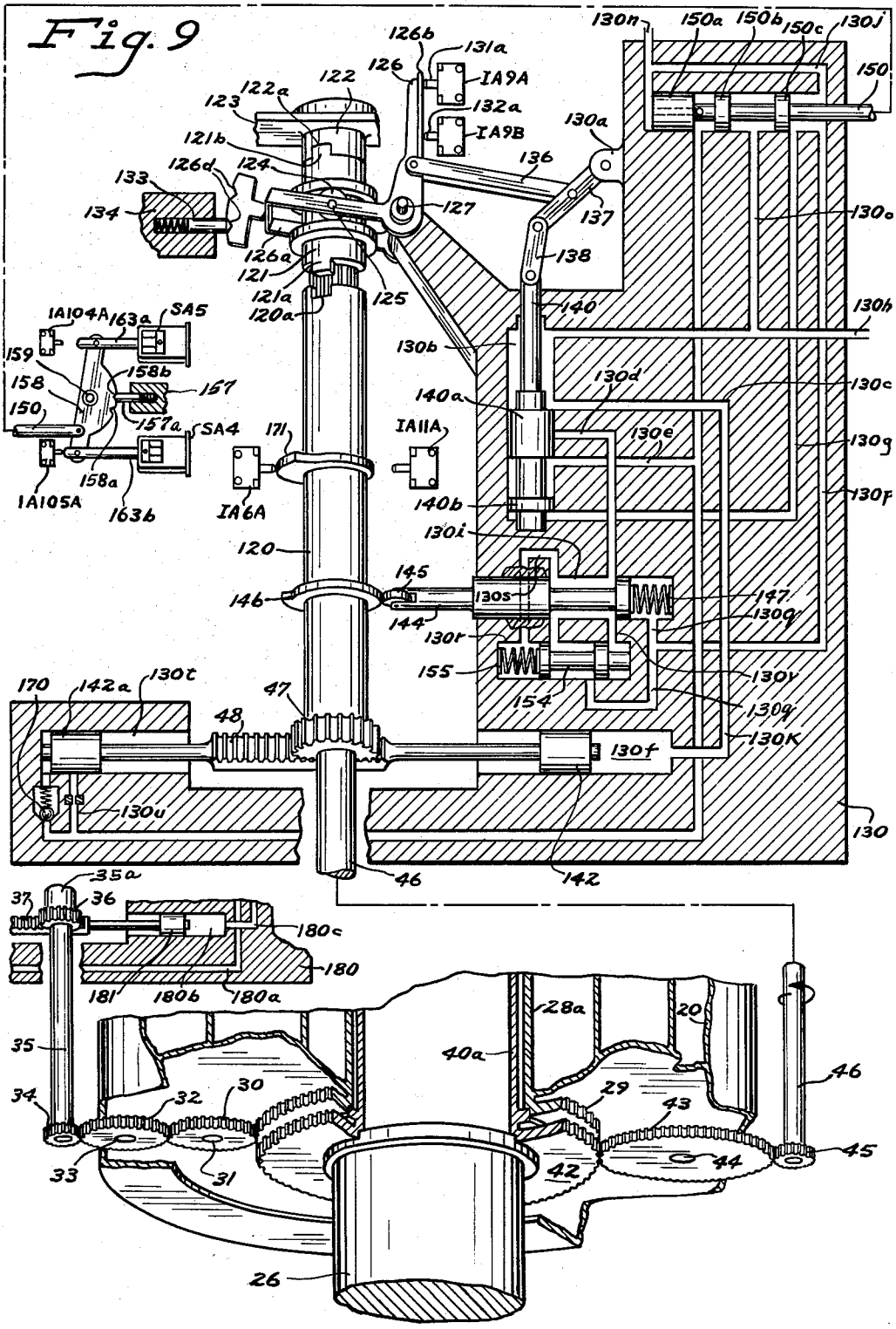
Fig. 7

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 8

Fig. 9



Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 9

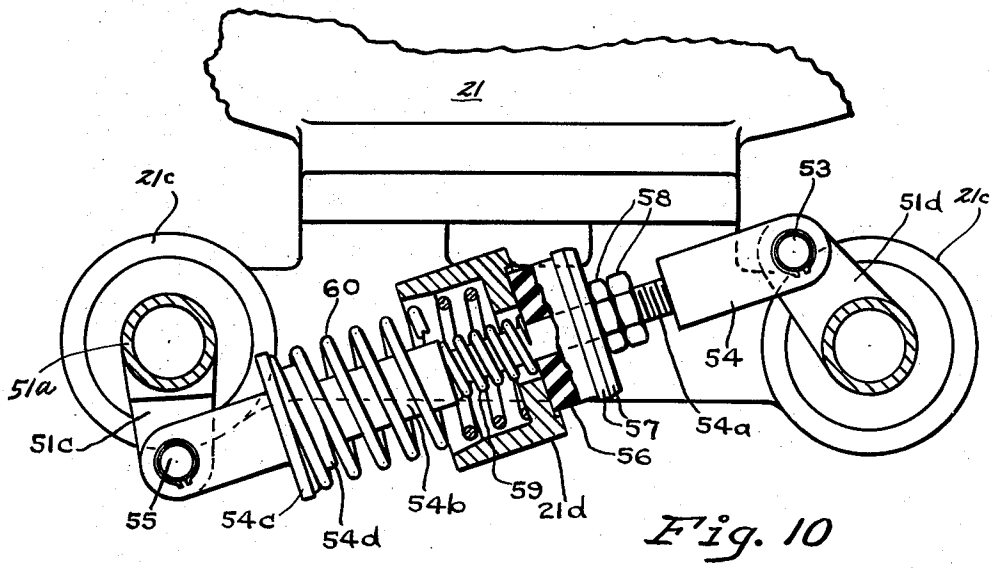


Fig. 10

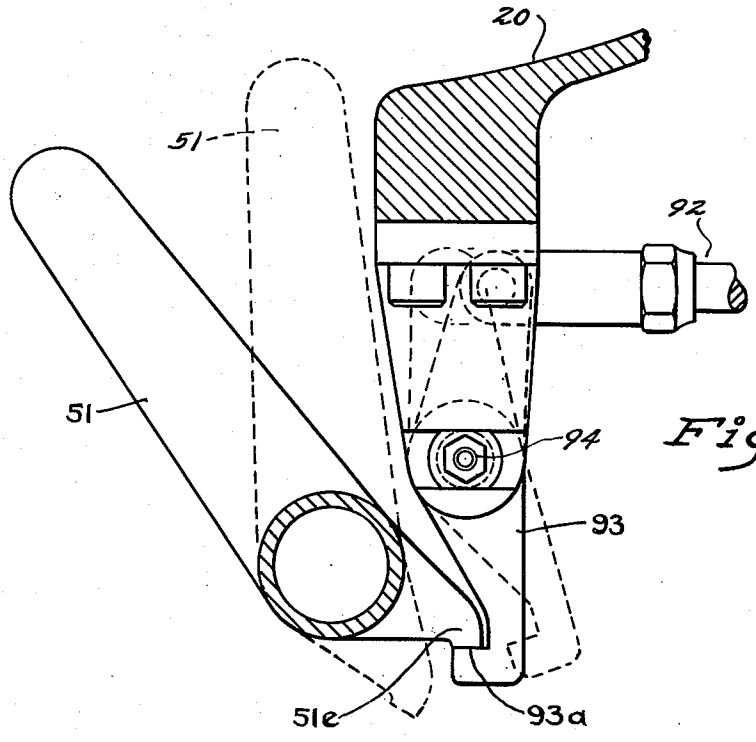


Fig. 11

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 10

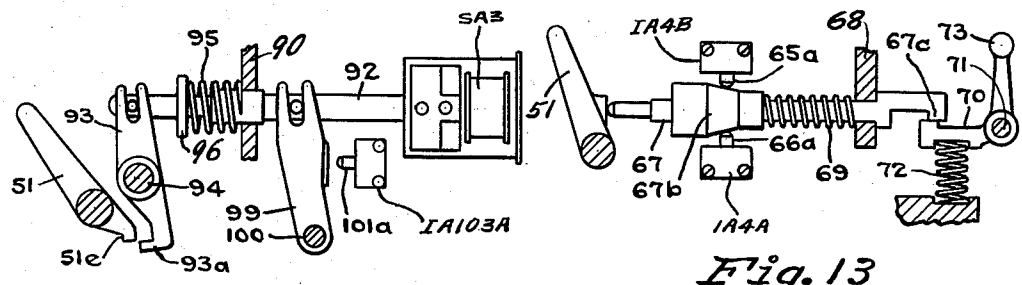


Fig. 12

Fig. 13

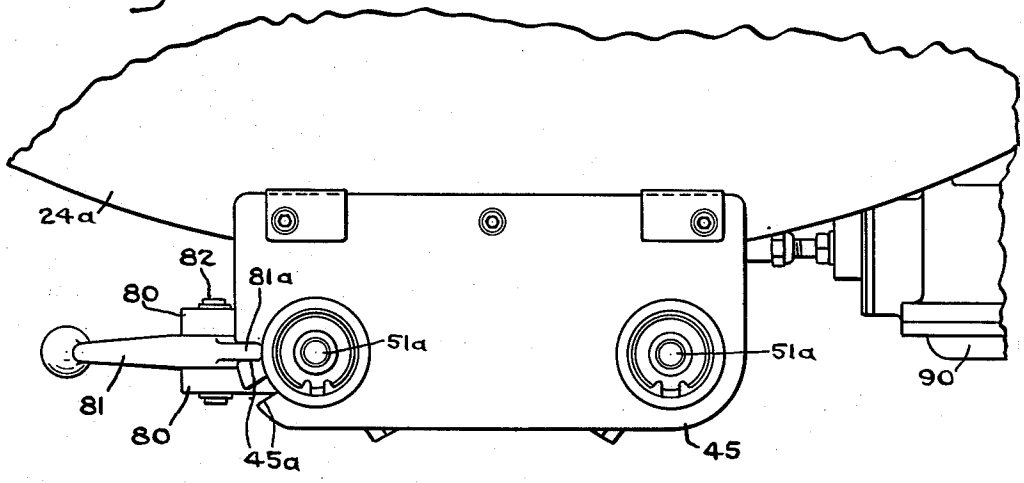


Fig. 14

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 11

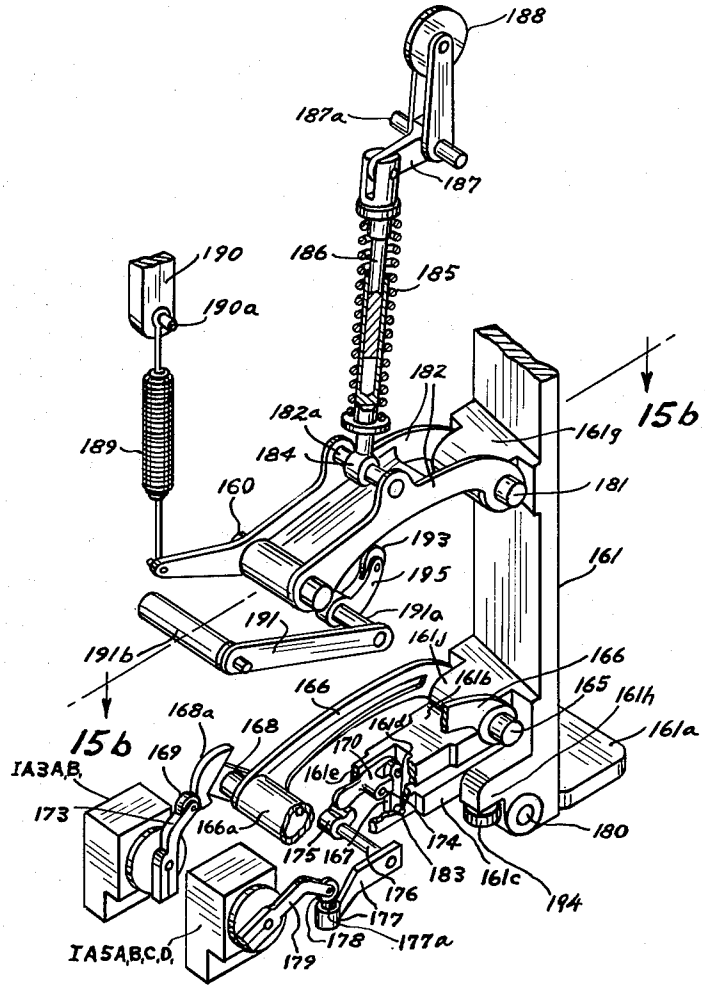


Fig. 15

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 12

Fig. 15a

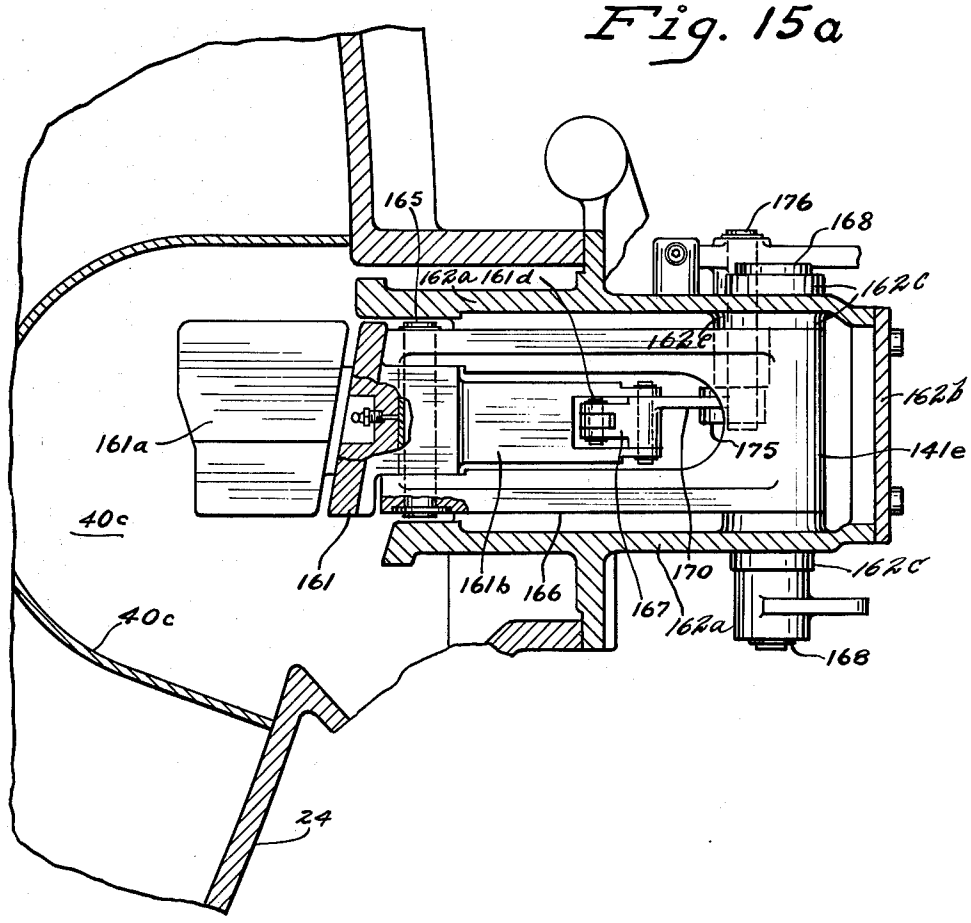
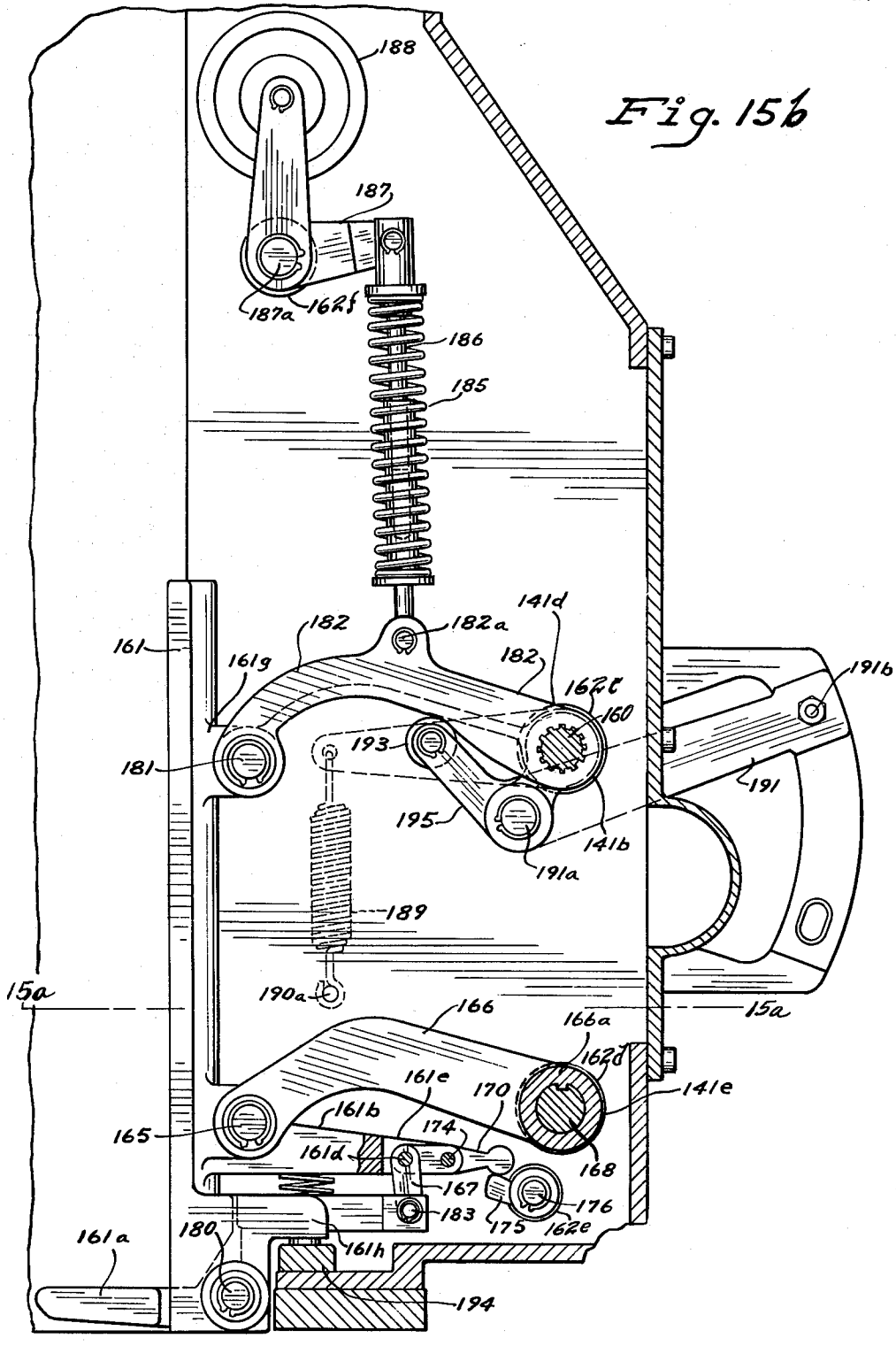


Fig. 15b


188
187
187a
162f
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141d
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182a
161
161g
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162c
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191b
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181
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141b
191a
189
190a
15a
166
166a
162d
161e
170
141e
161b
165
174
161d
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167
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162e
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161h
194

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 14

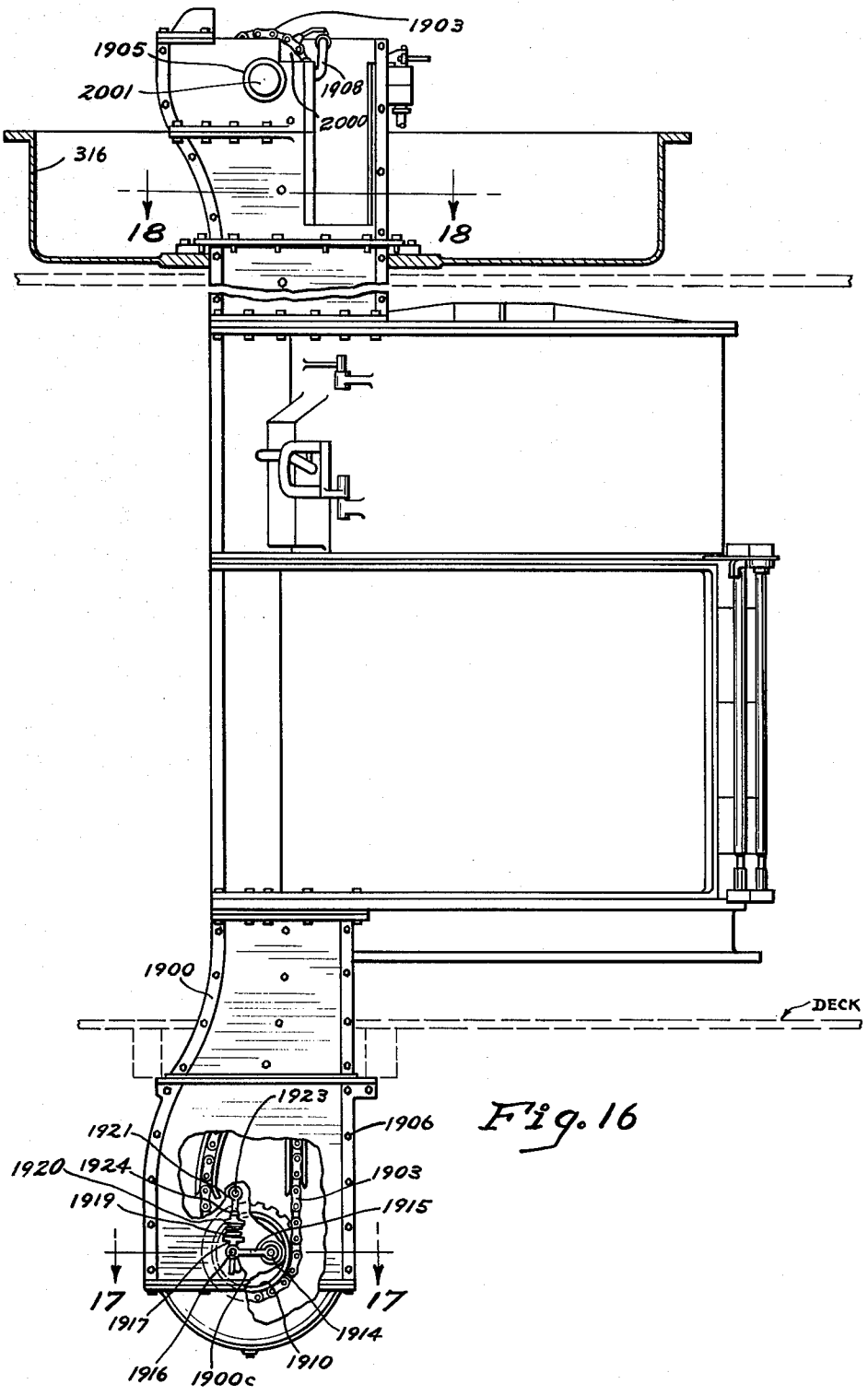


Fig. 16

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 15

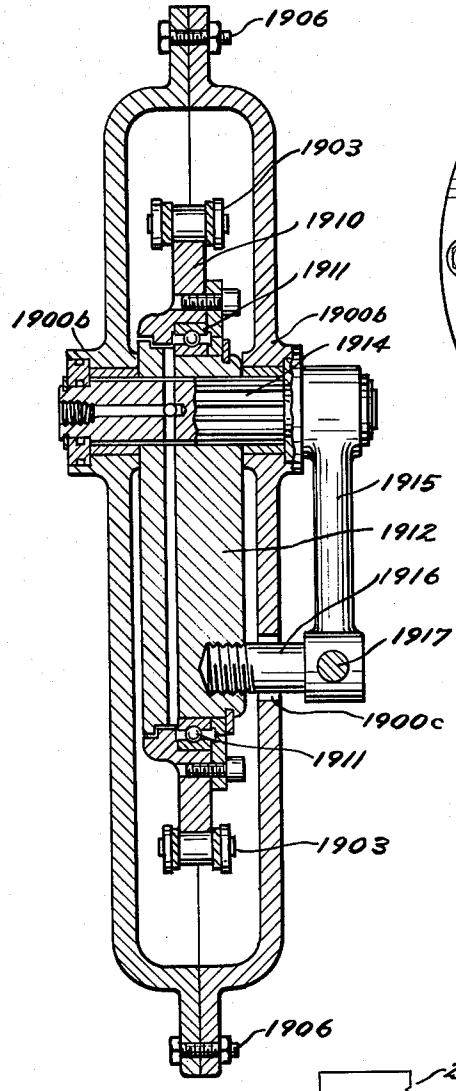


Fig. 17

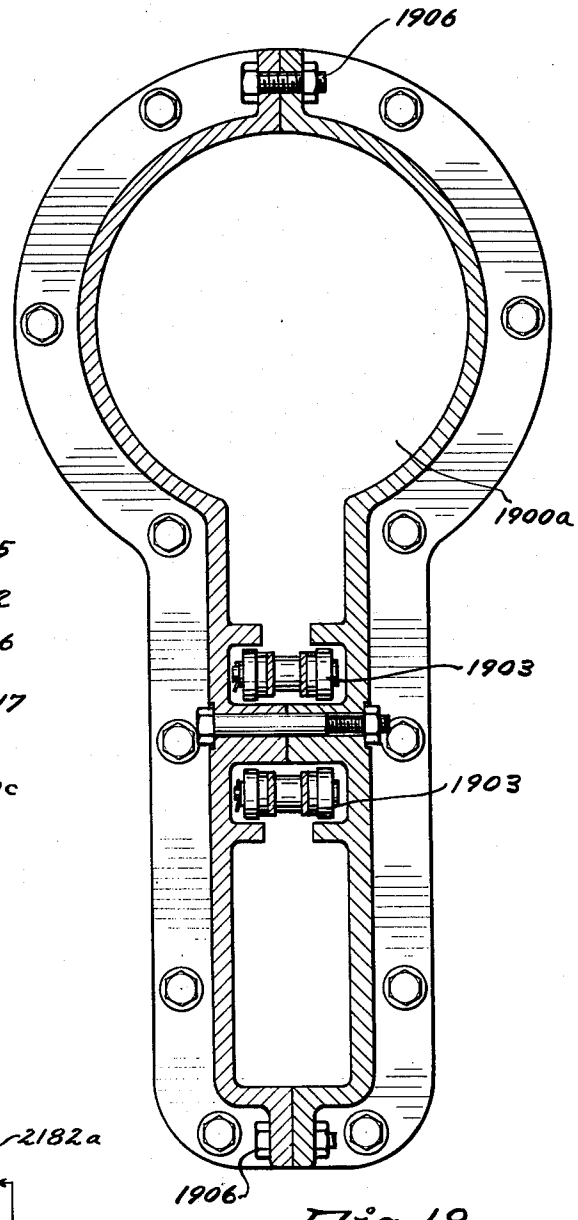


Fig. 18

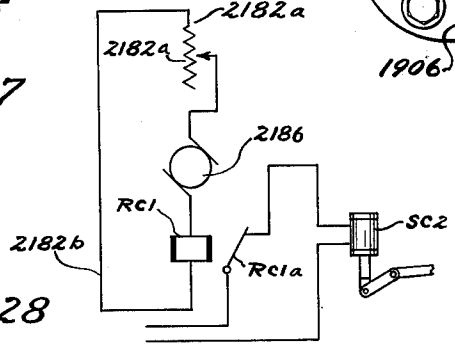


Fig. 28

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 16

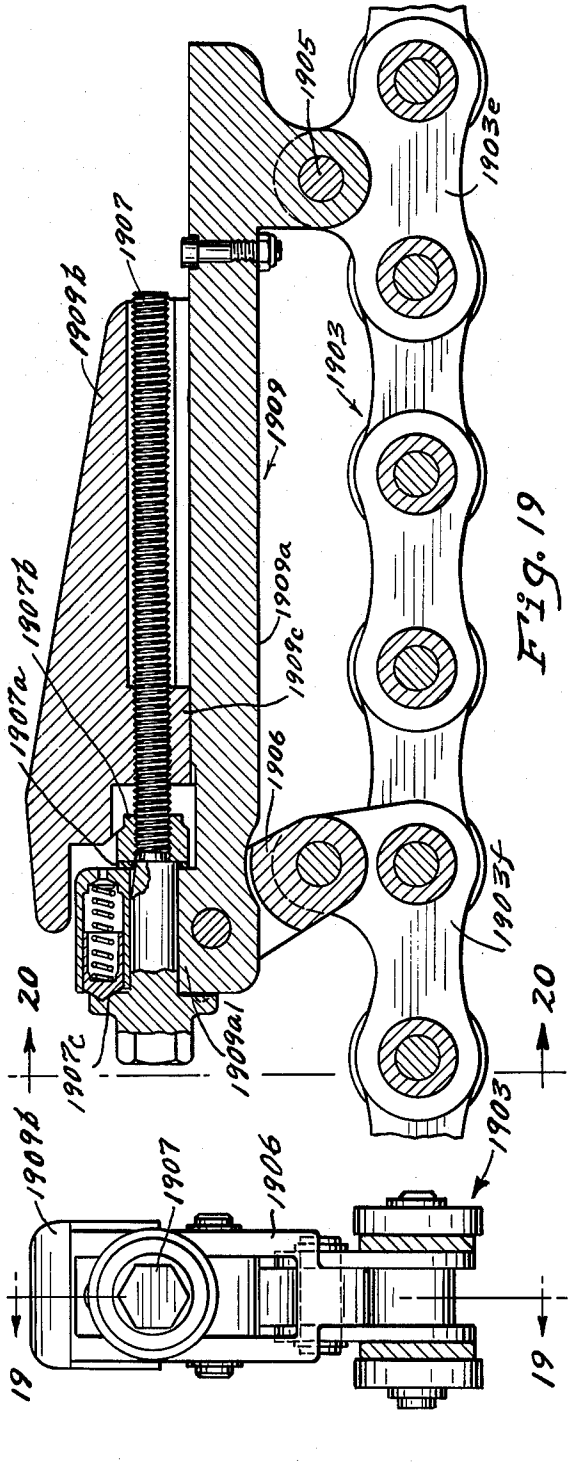


Fig. 19

Fig. 20

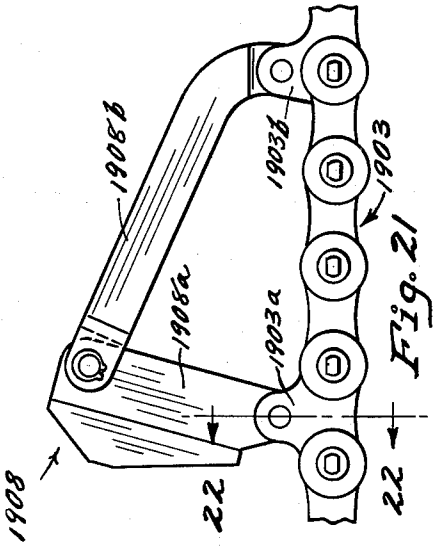


Fig. 21

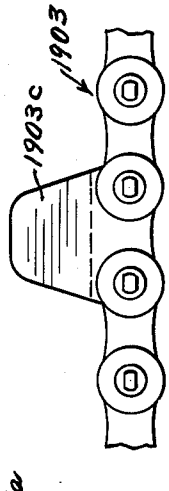
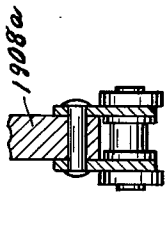


Fig. 23



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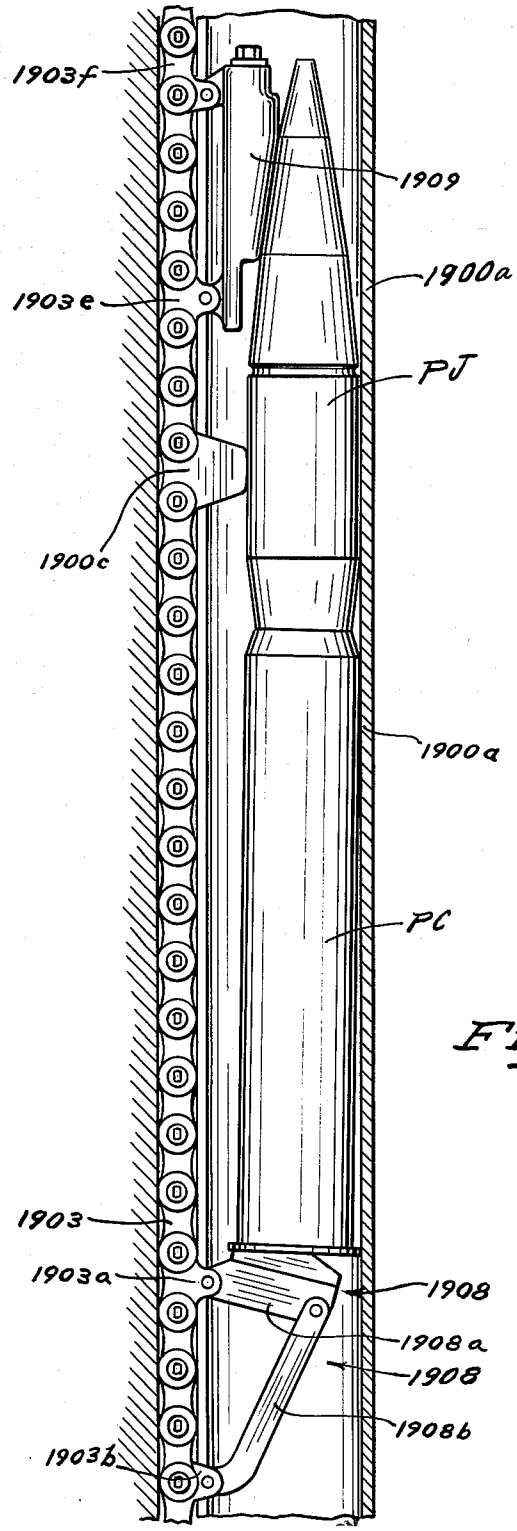
1903f
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1900c
1900a
PC
1903
1903a
1908
1908a
1908
1908b
1903b

Fig. 24

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 18

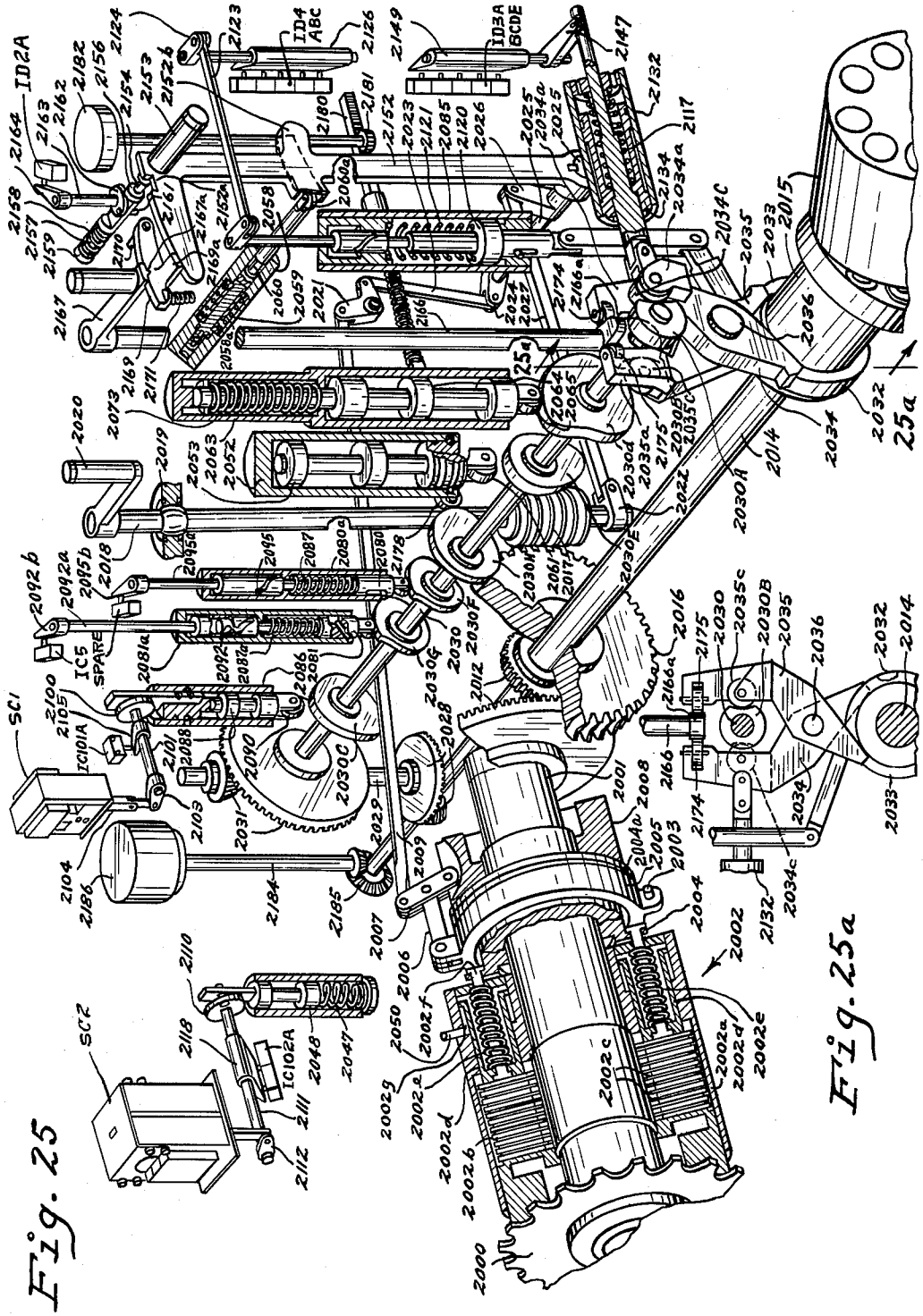

Fig. 25

Fig. 25a

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

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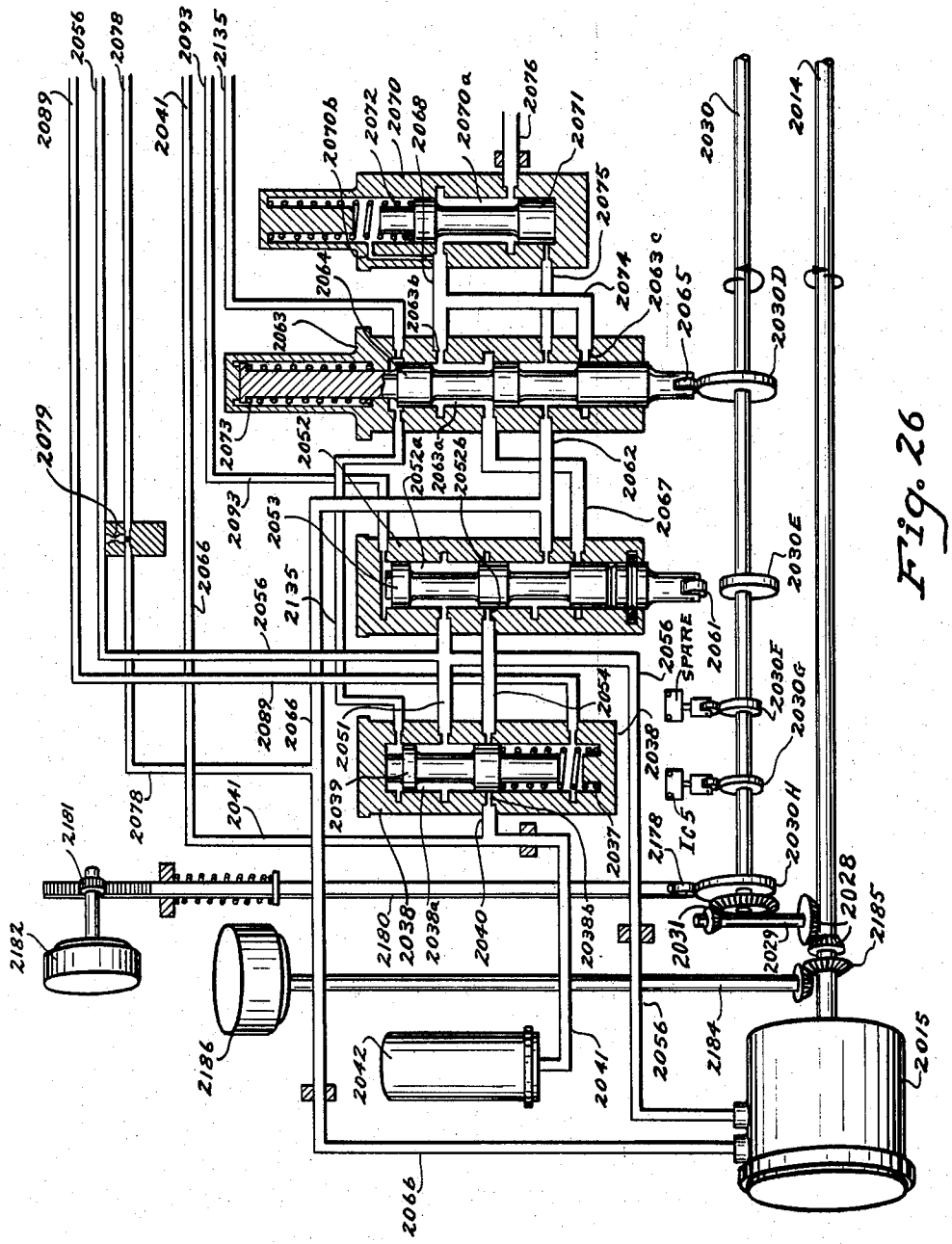
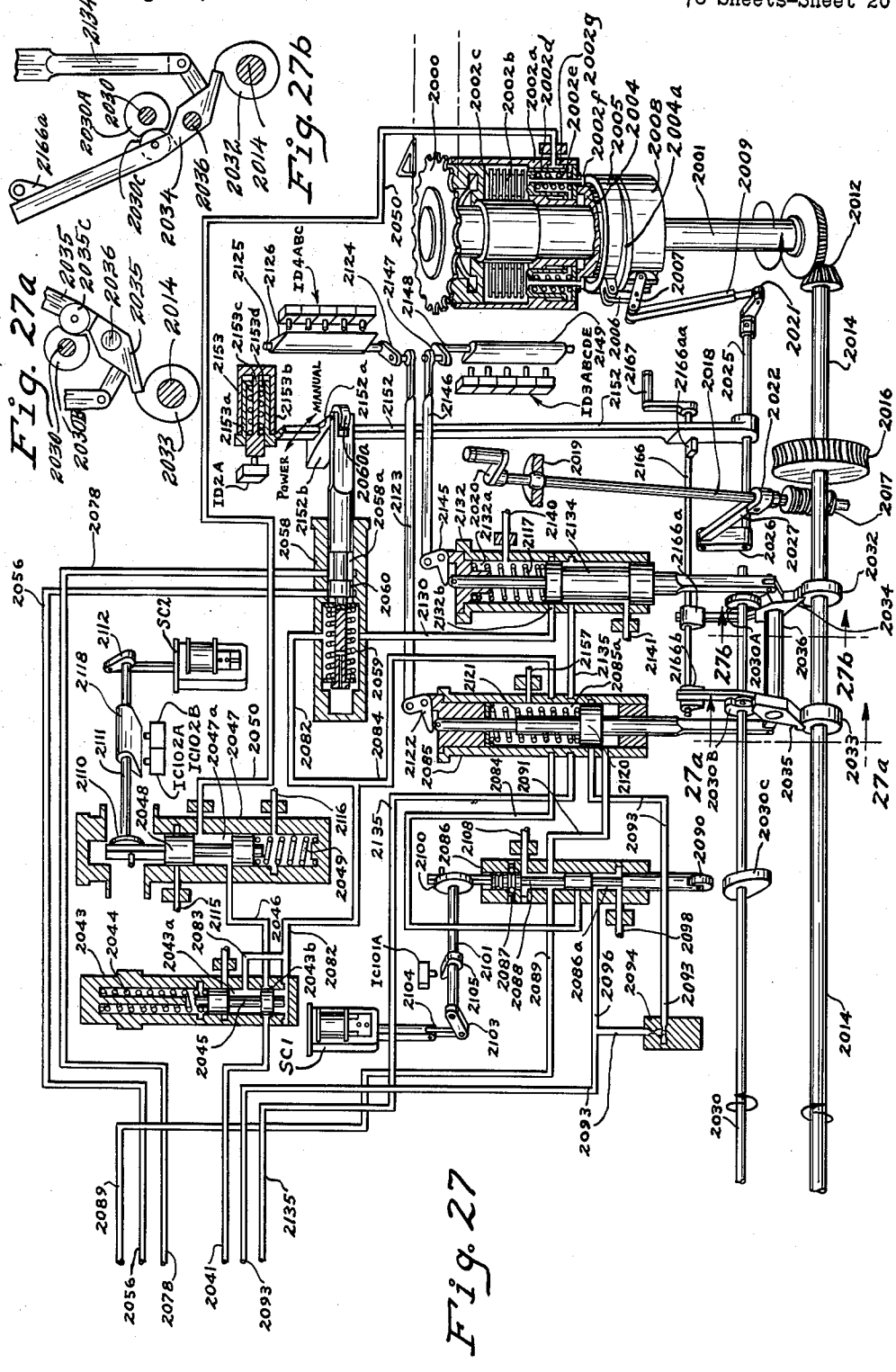


Fig. 26

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 20



GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 21

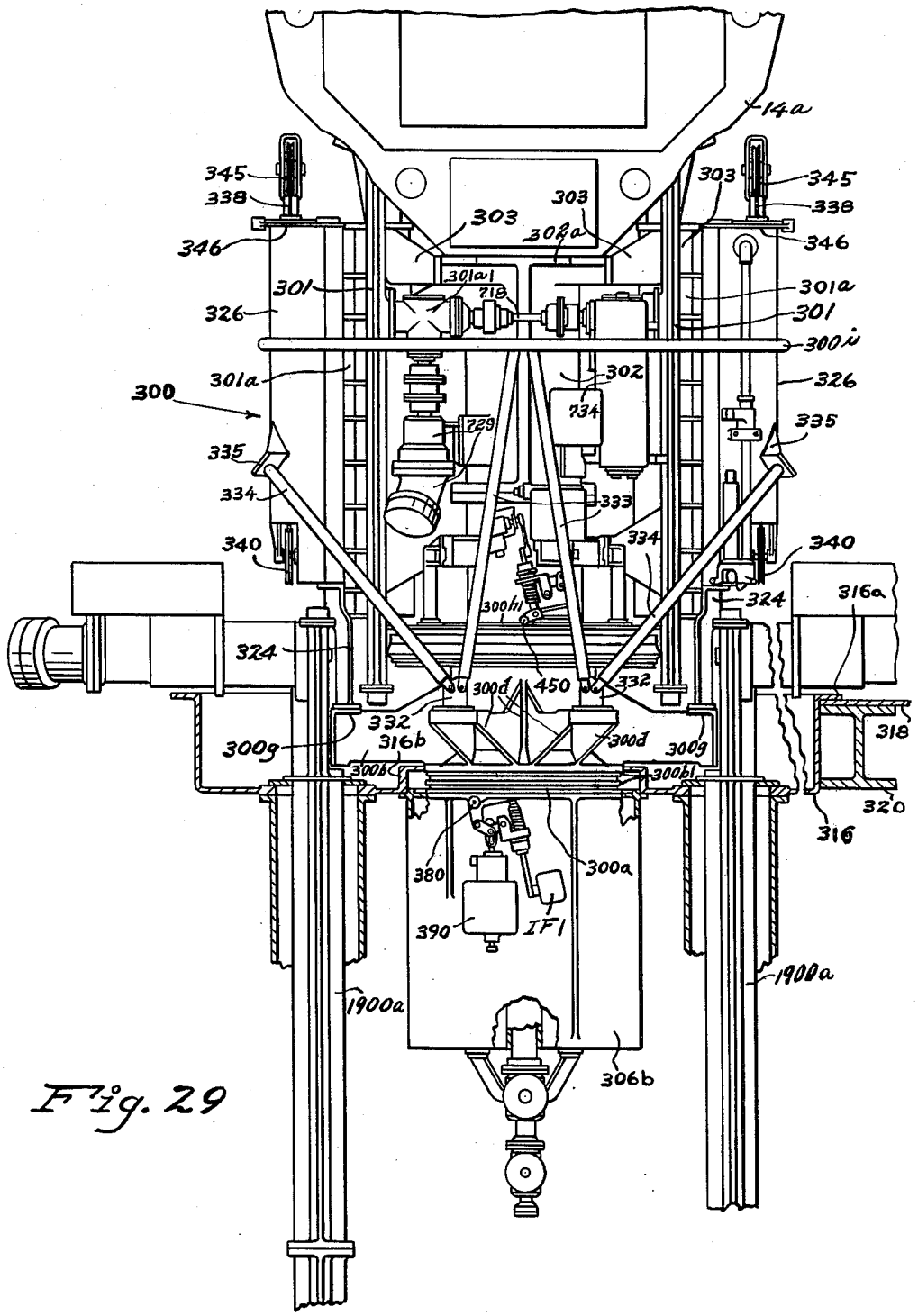


Fig. 29

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 22

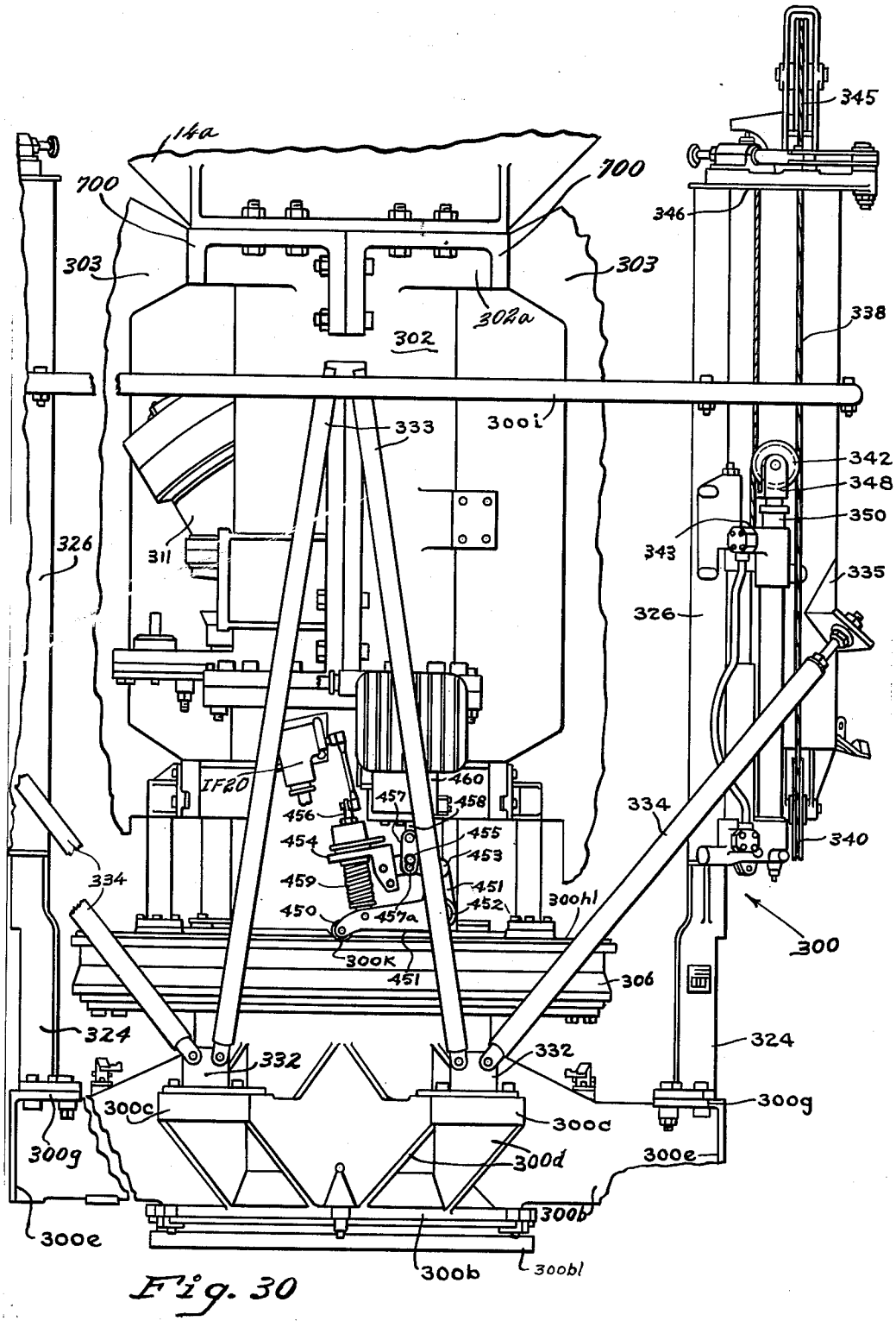


Fig. 30

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 23

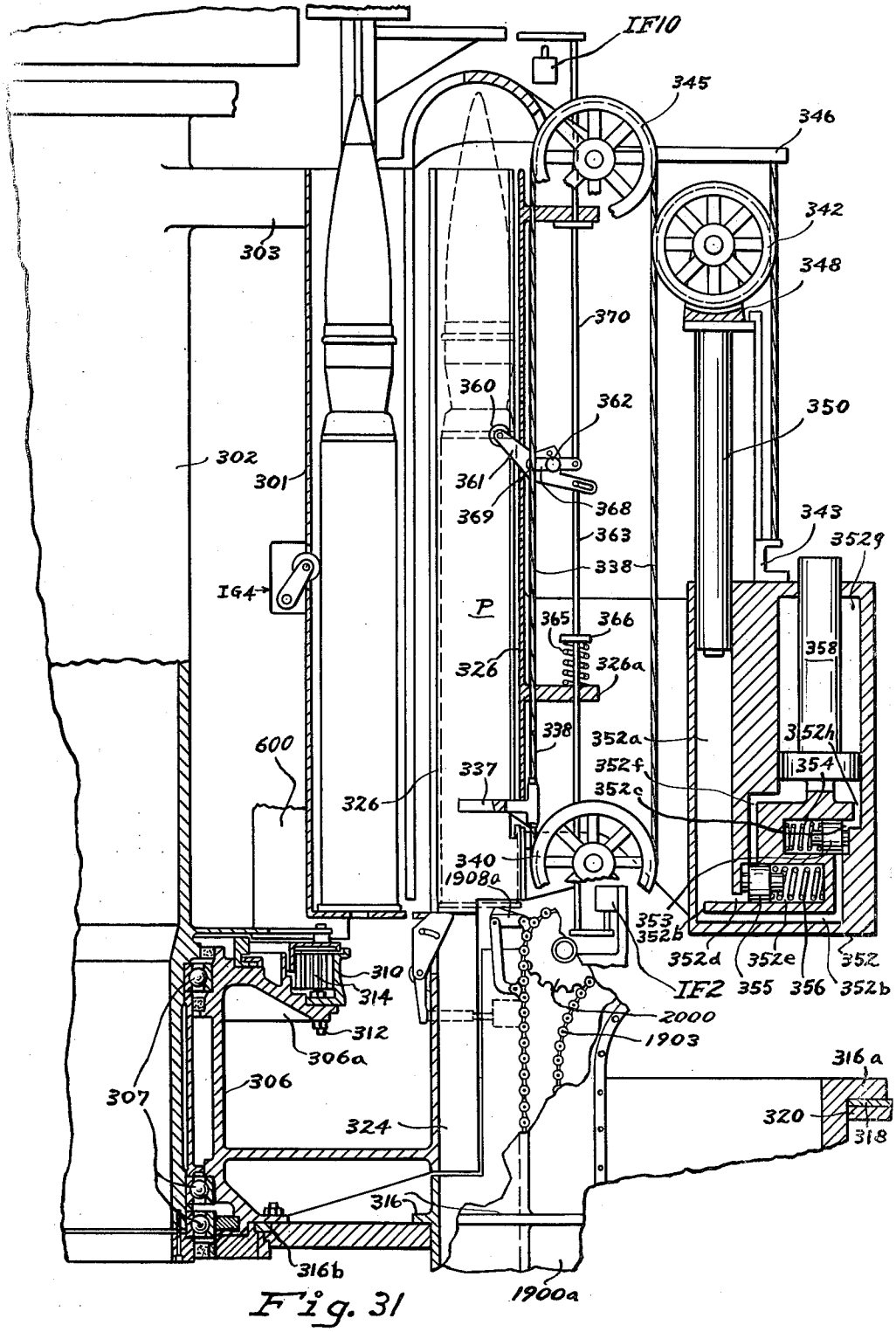


Fig. 31

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 24

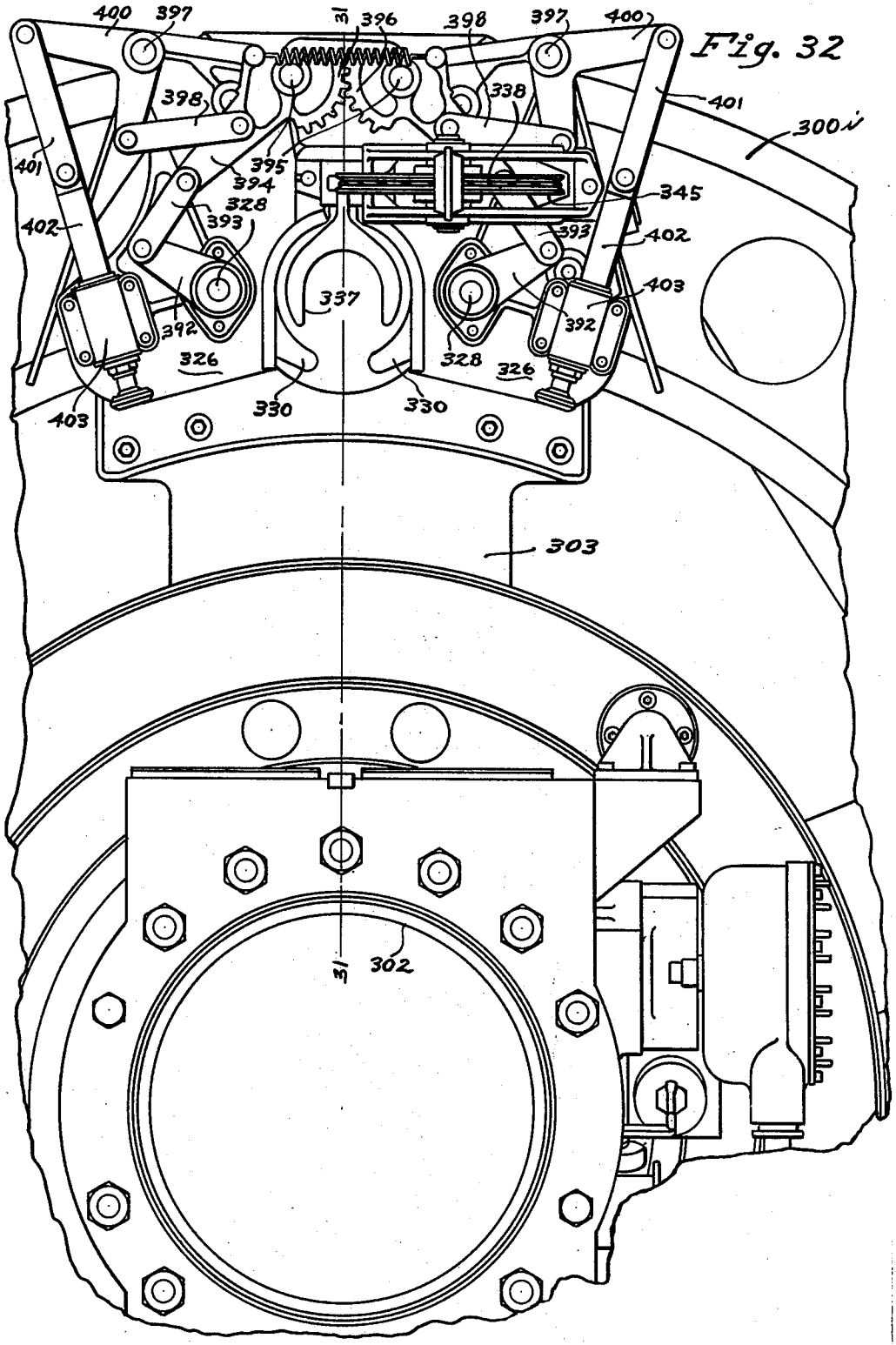


Fig. 32

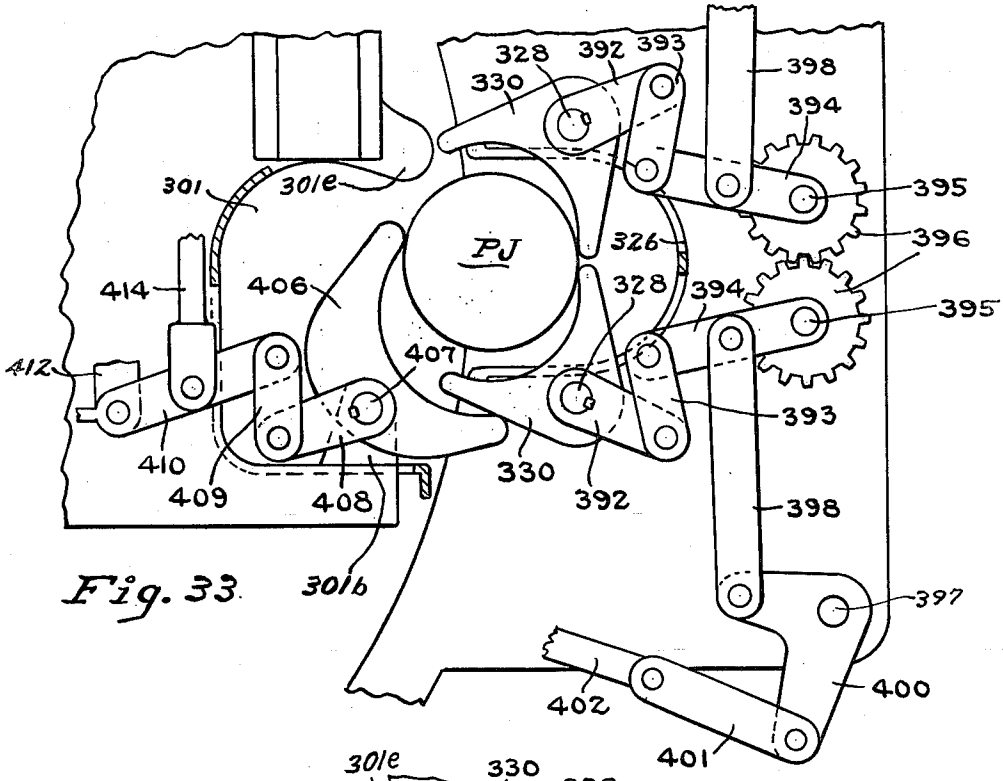

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Fig. 33

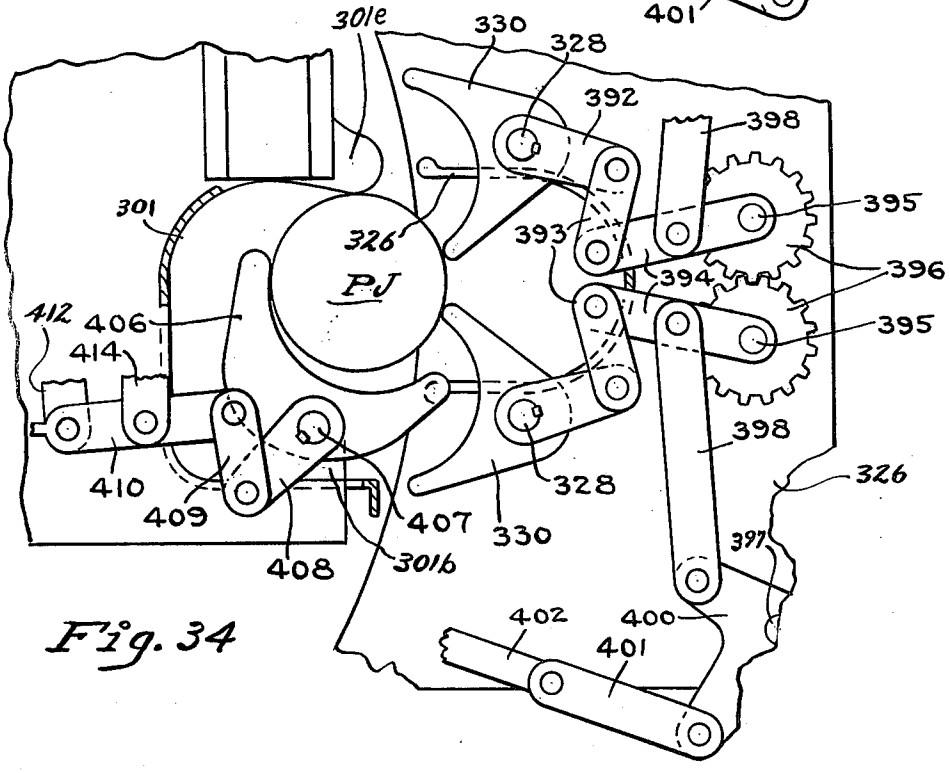
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Fig. 34

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 26

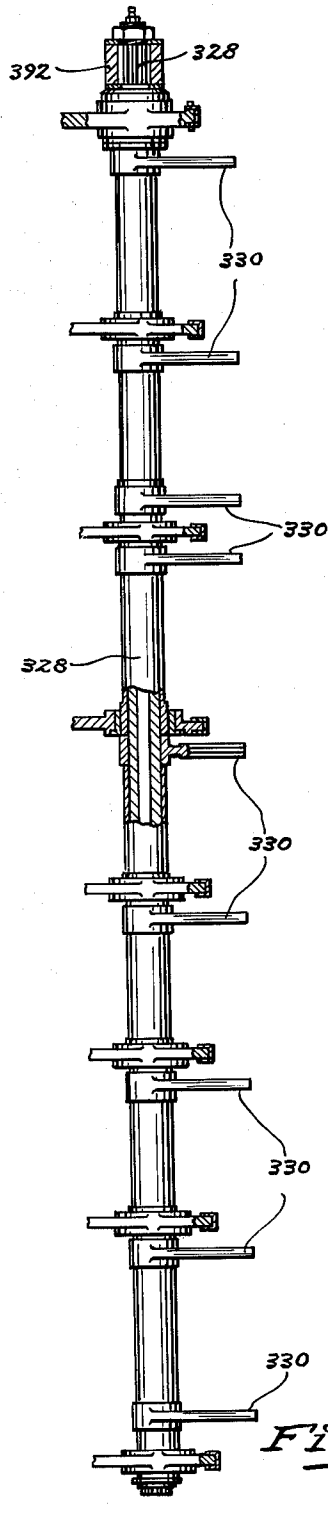


Fig. 36

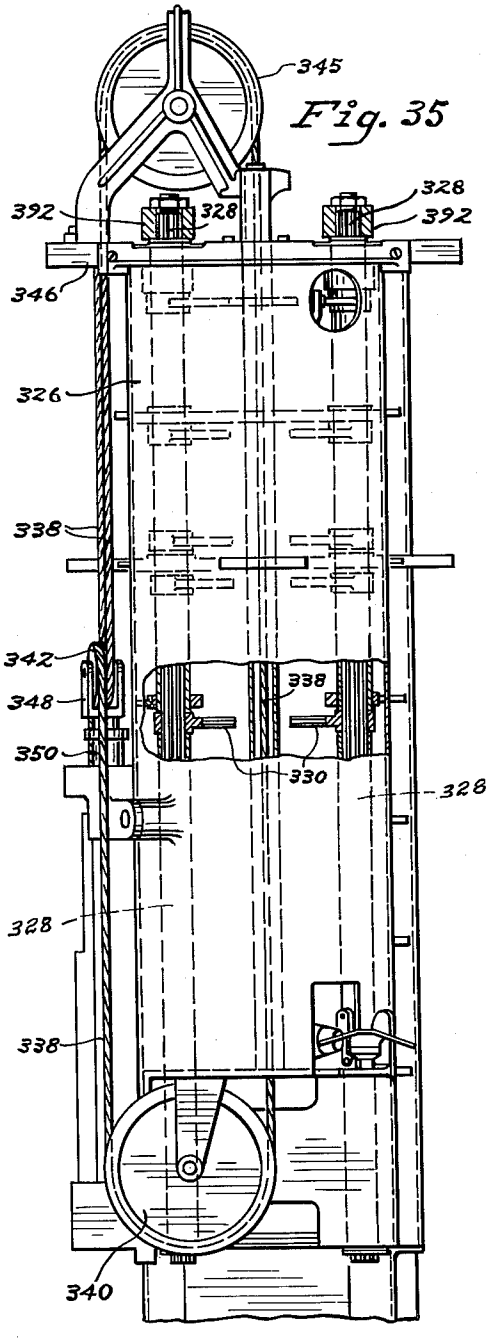


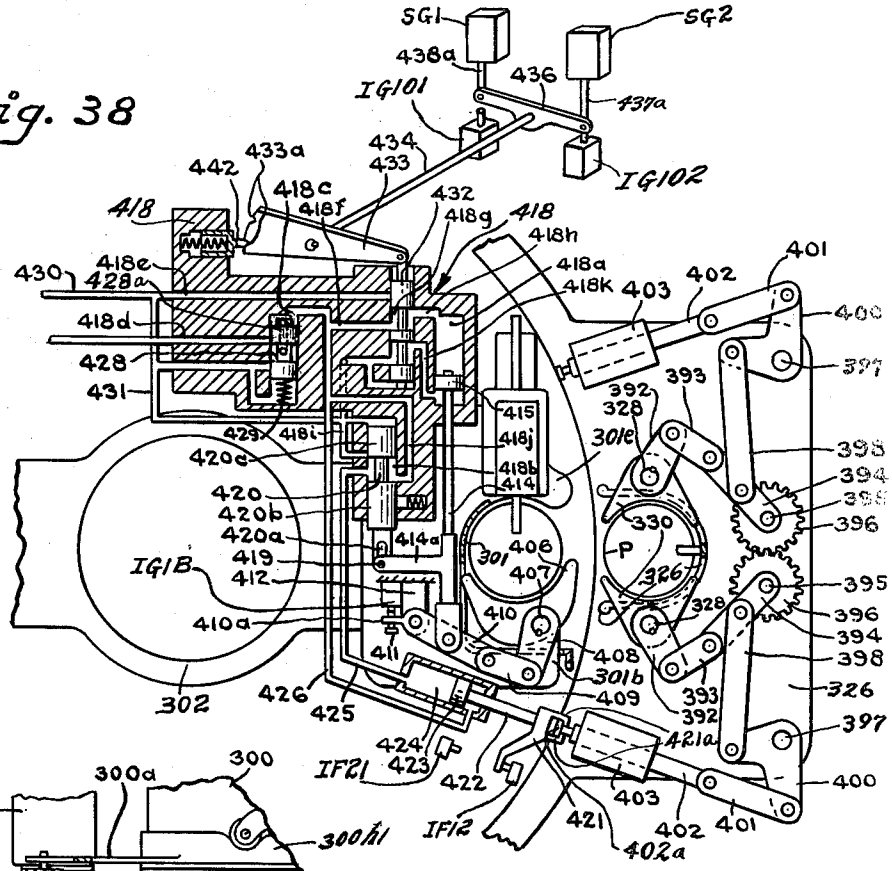
Fig. 35

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 27

Fig. 38



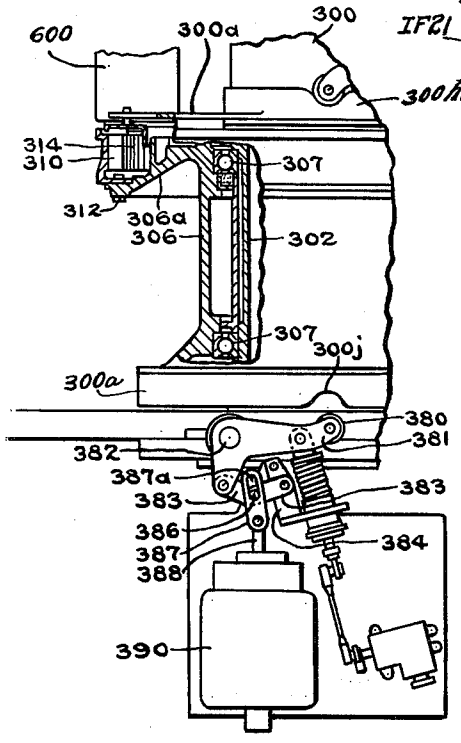


Fig. 39

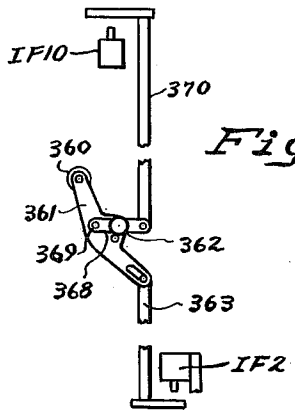


Fig. 37

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 28

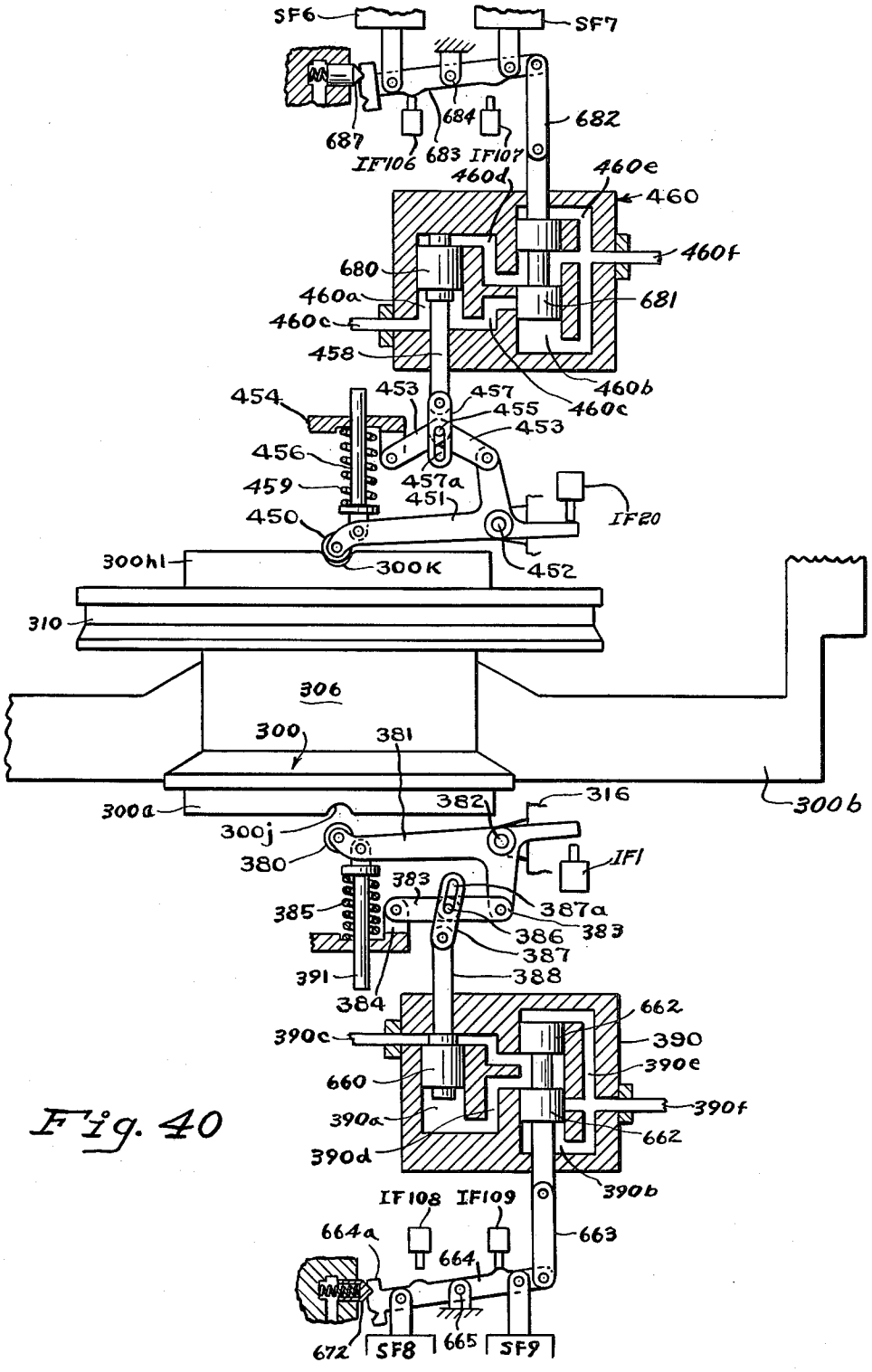


Fig. 40

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 29

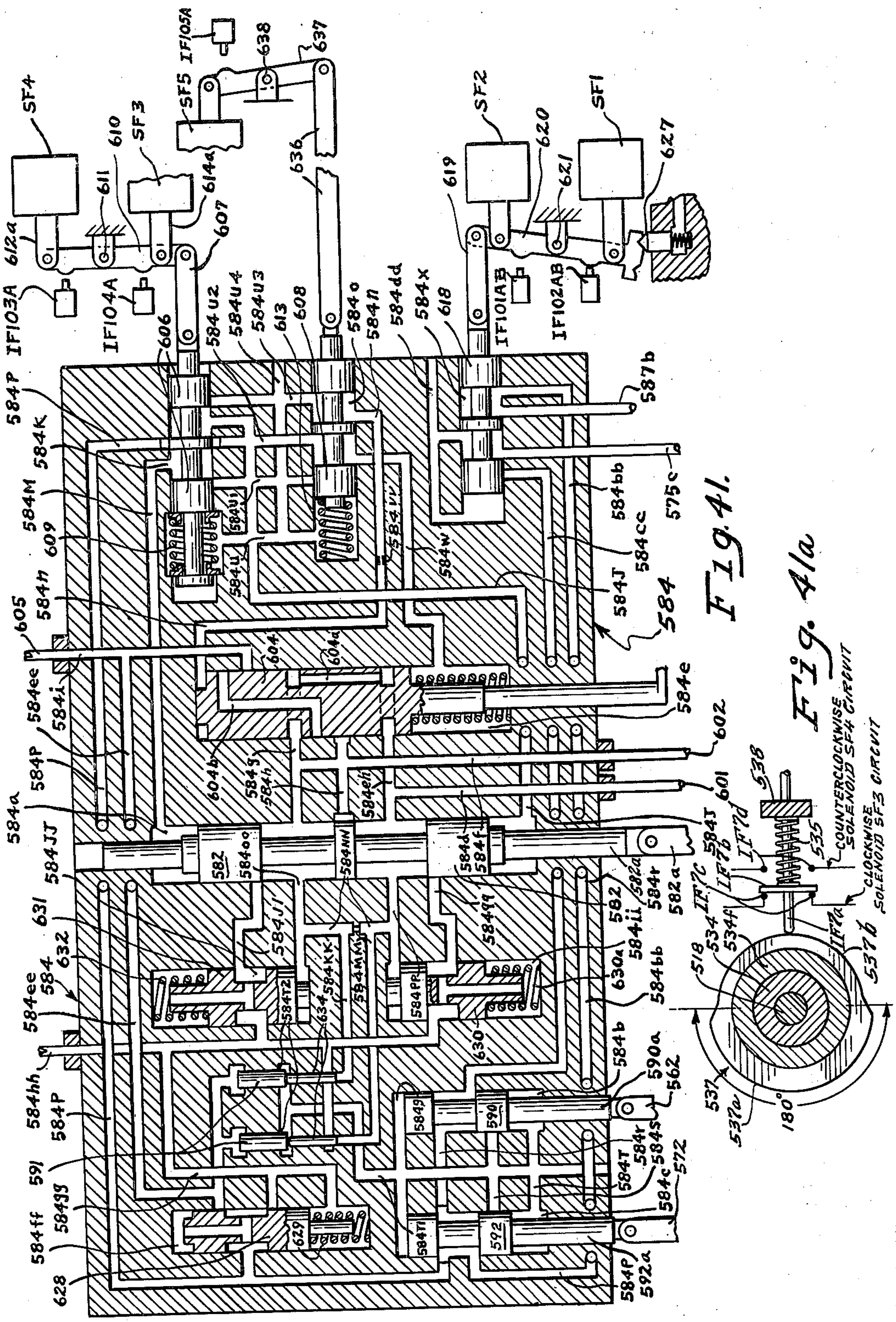


Fig. 41.

Fig. 41a

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 30

Fig. 43

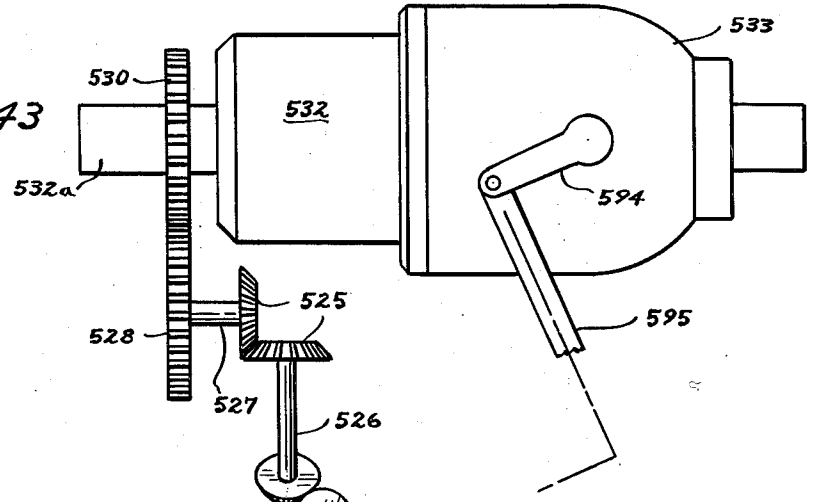


Fig. 43a

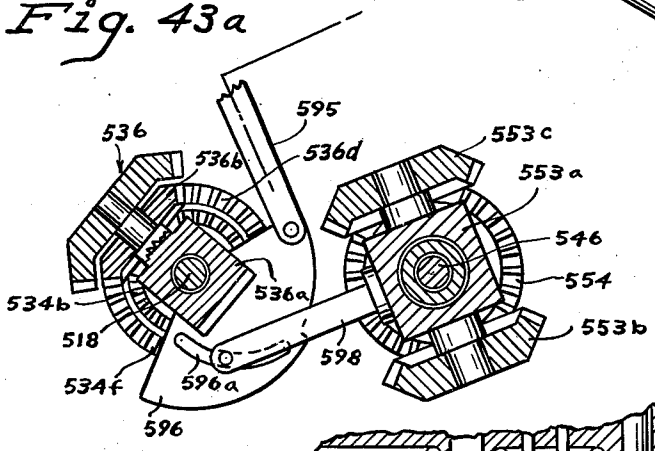
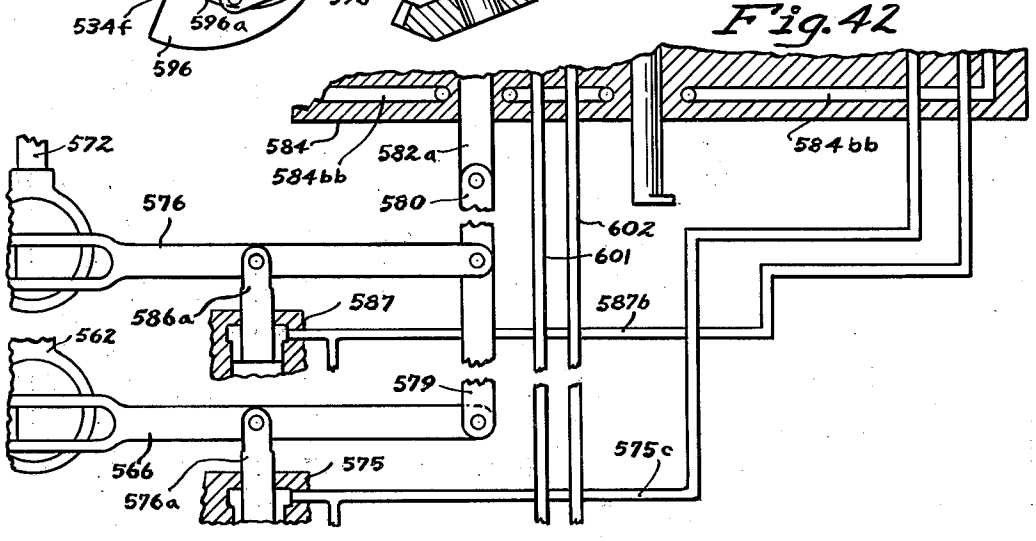


Fig. 42



Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 31

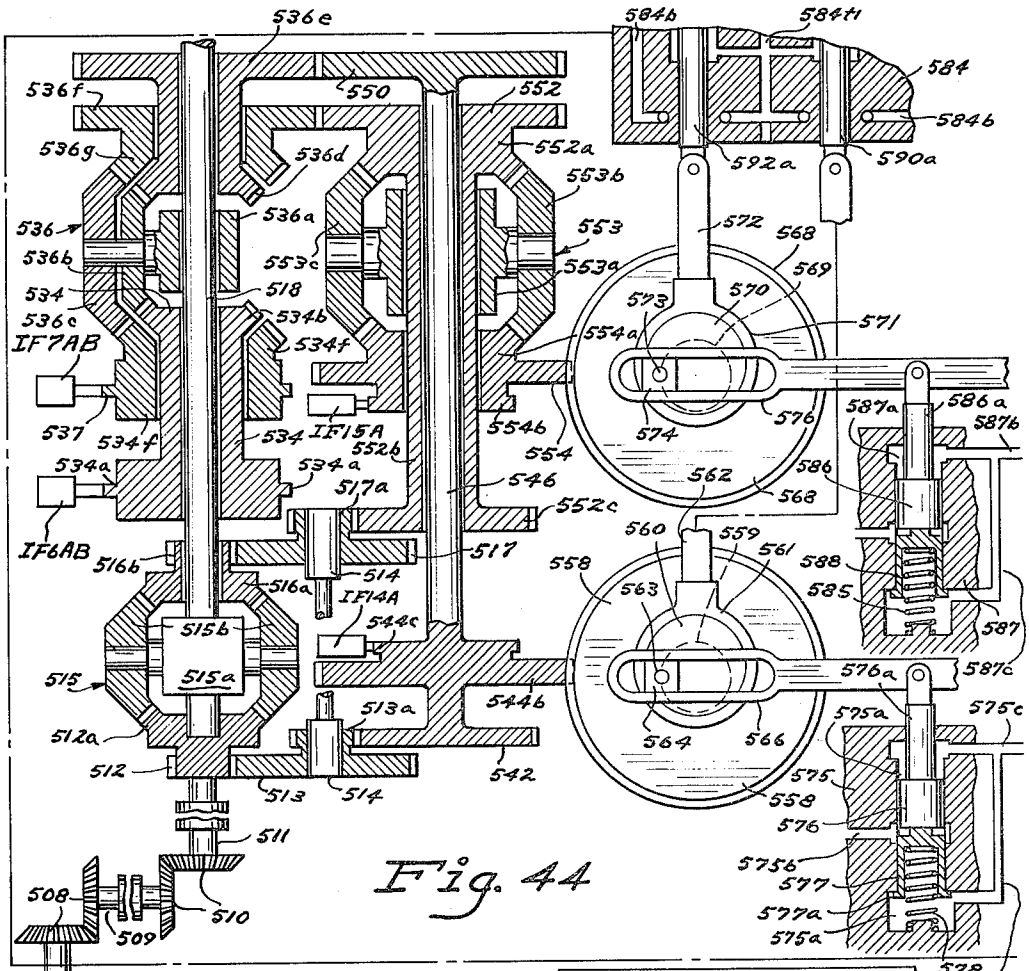


Fig. 44

Fig. 44a

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 32

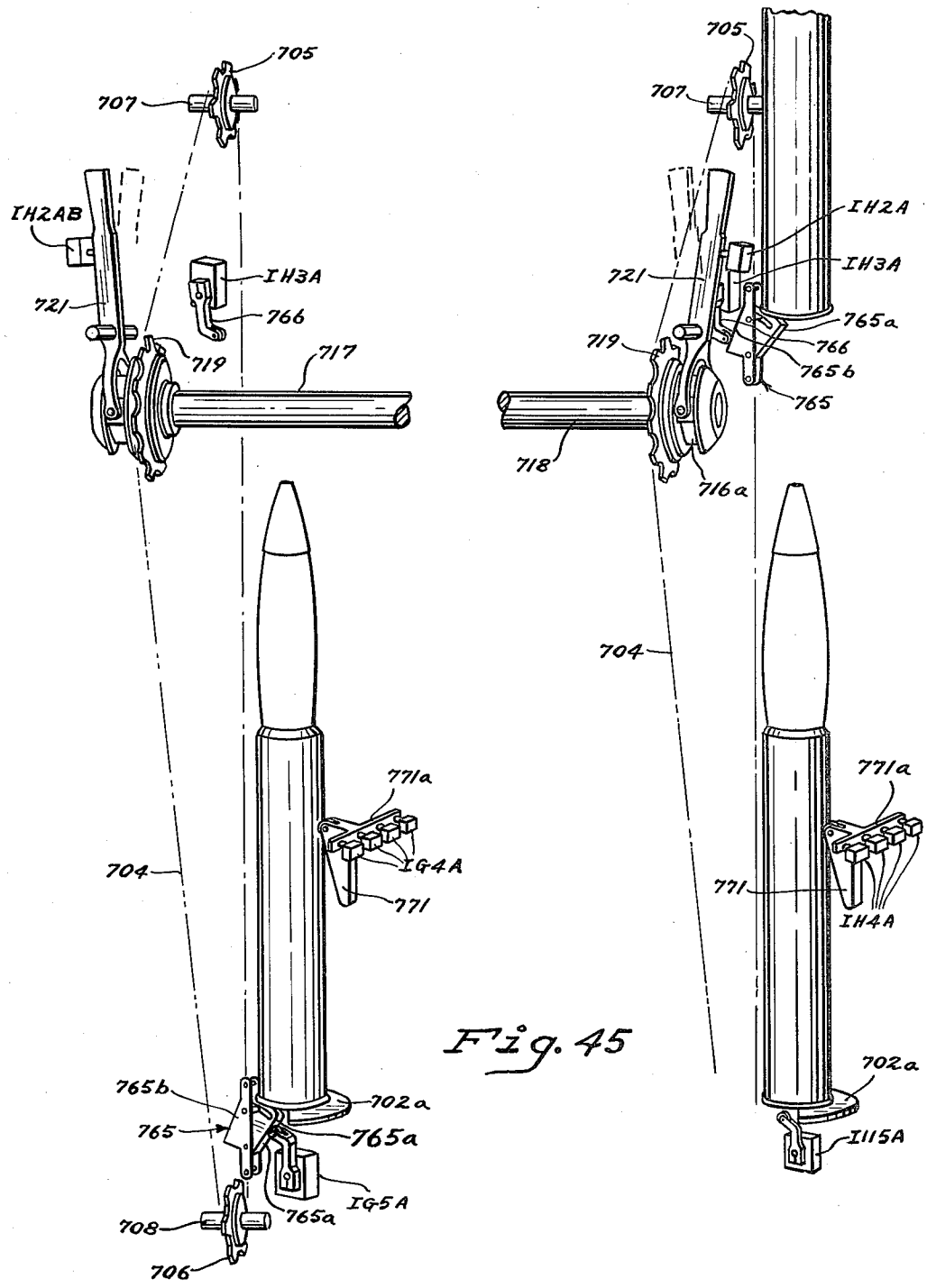


Fig. 45

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 33

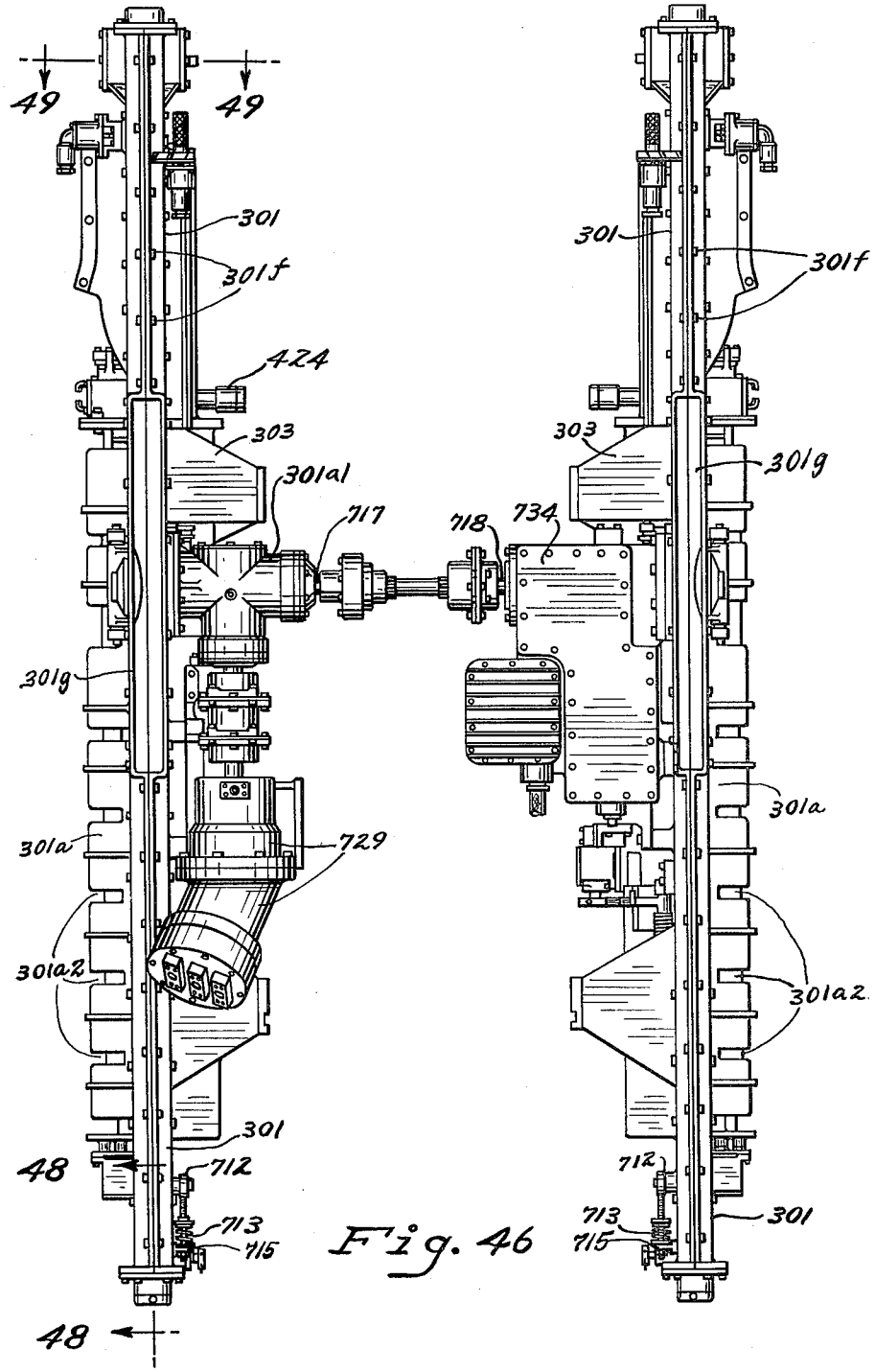


Fig. 46

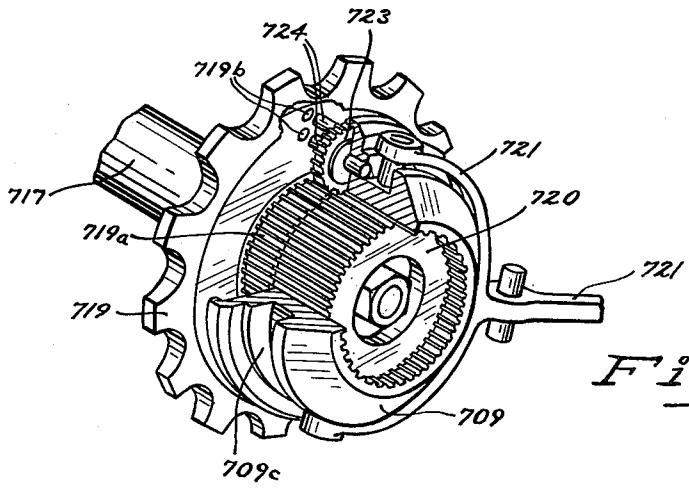

724
723
719b
721
717
720
719a
721
719
709
709c

Fig. 47

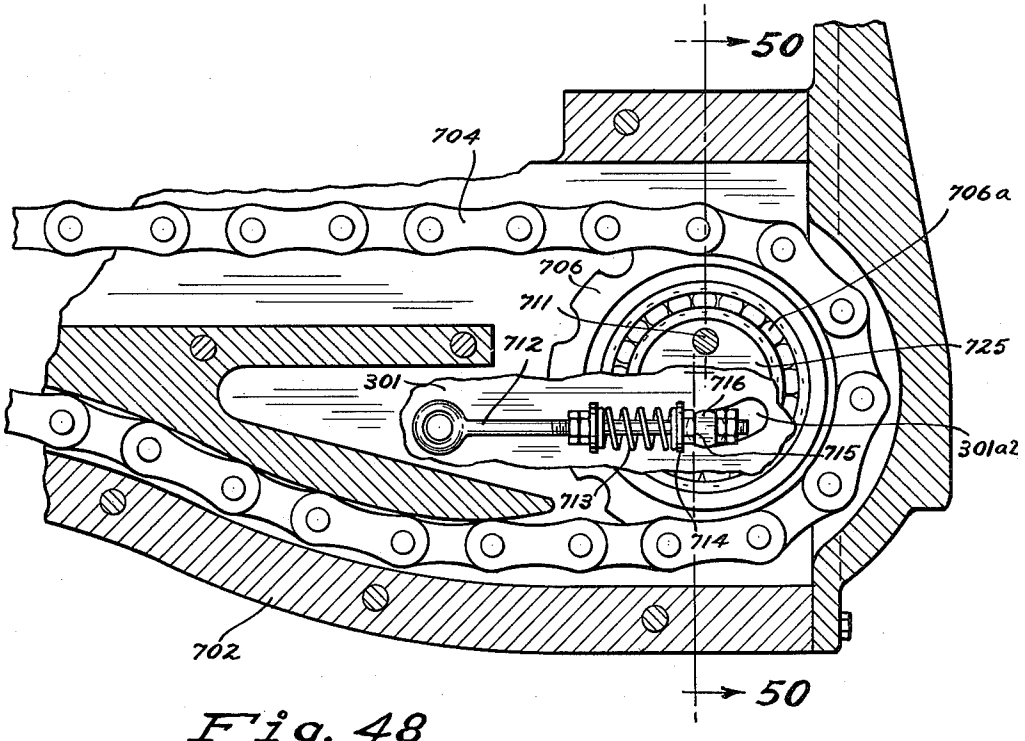

50
704
706a
706
711
712
725
301
716
715
301a2
713
714
702
50

Fig. 48

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 35

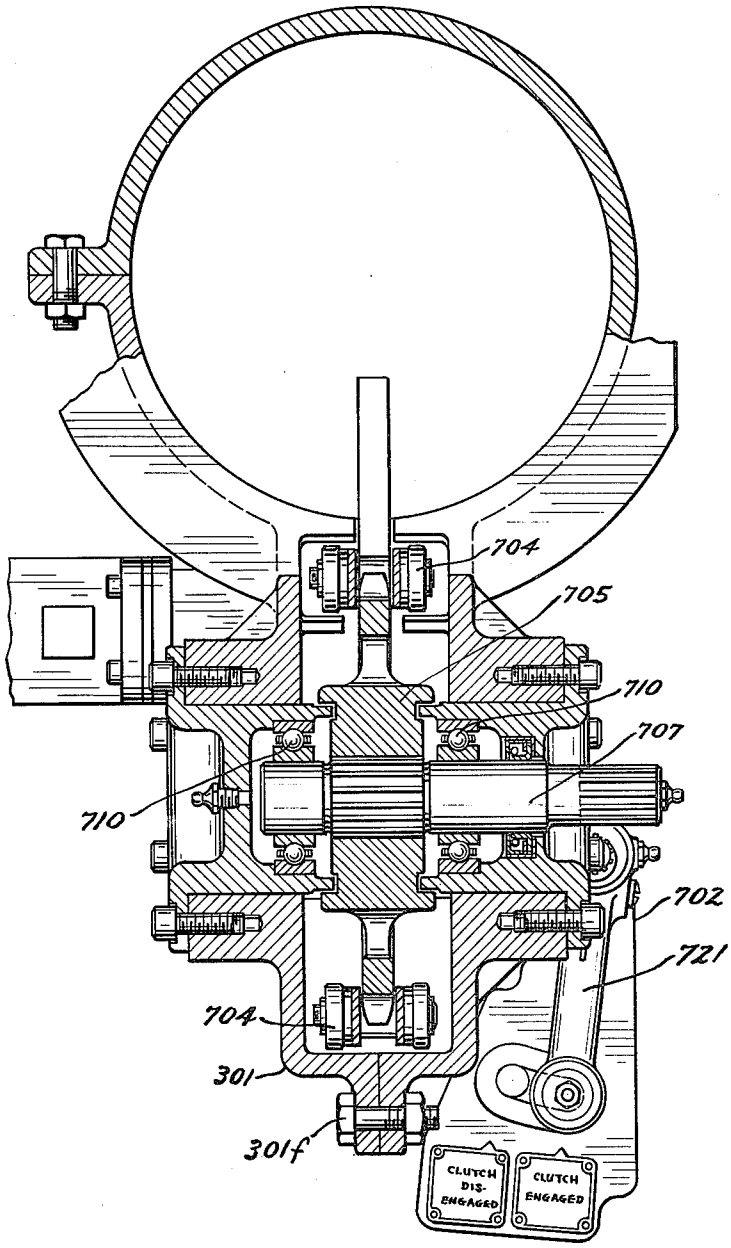


Fig. 49

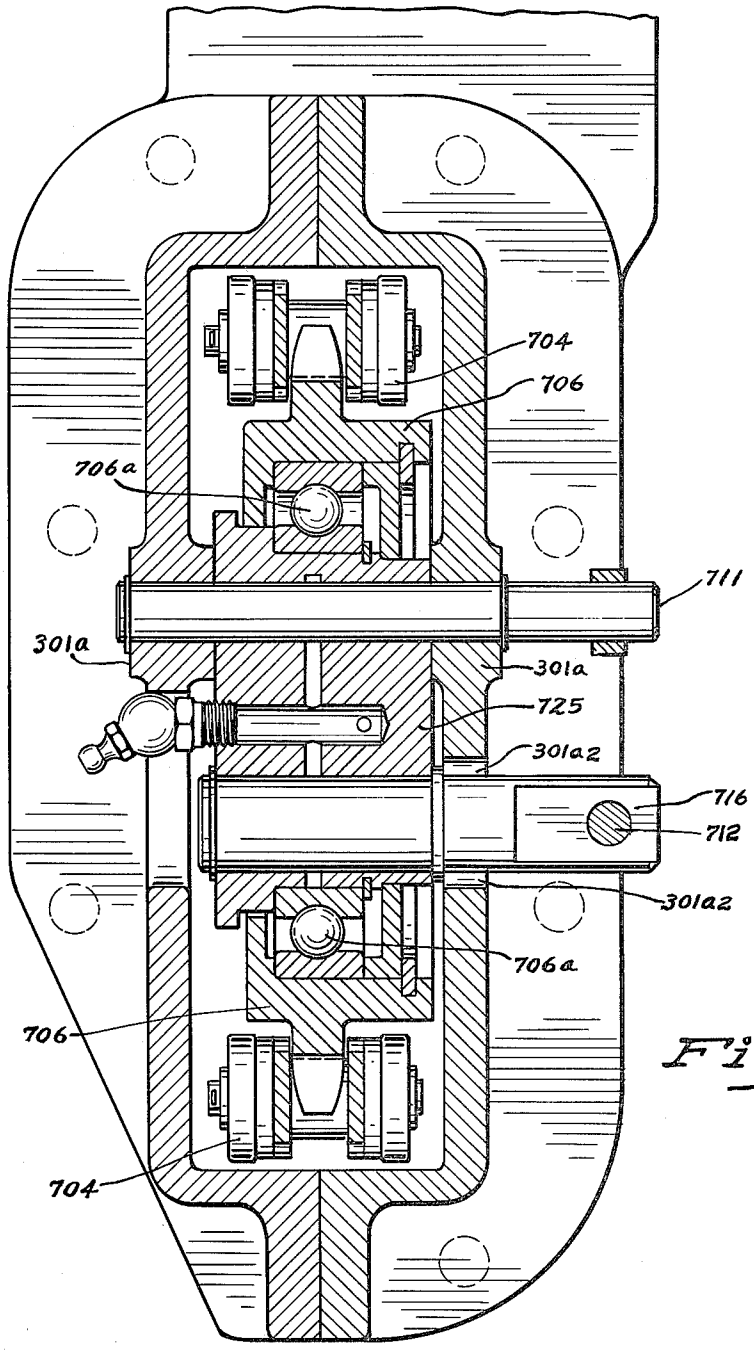

704
706
706a
711
301a
301a
725
301a2
716
712
301a2
706a
706
704

Fig. 50

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 37

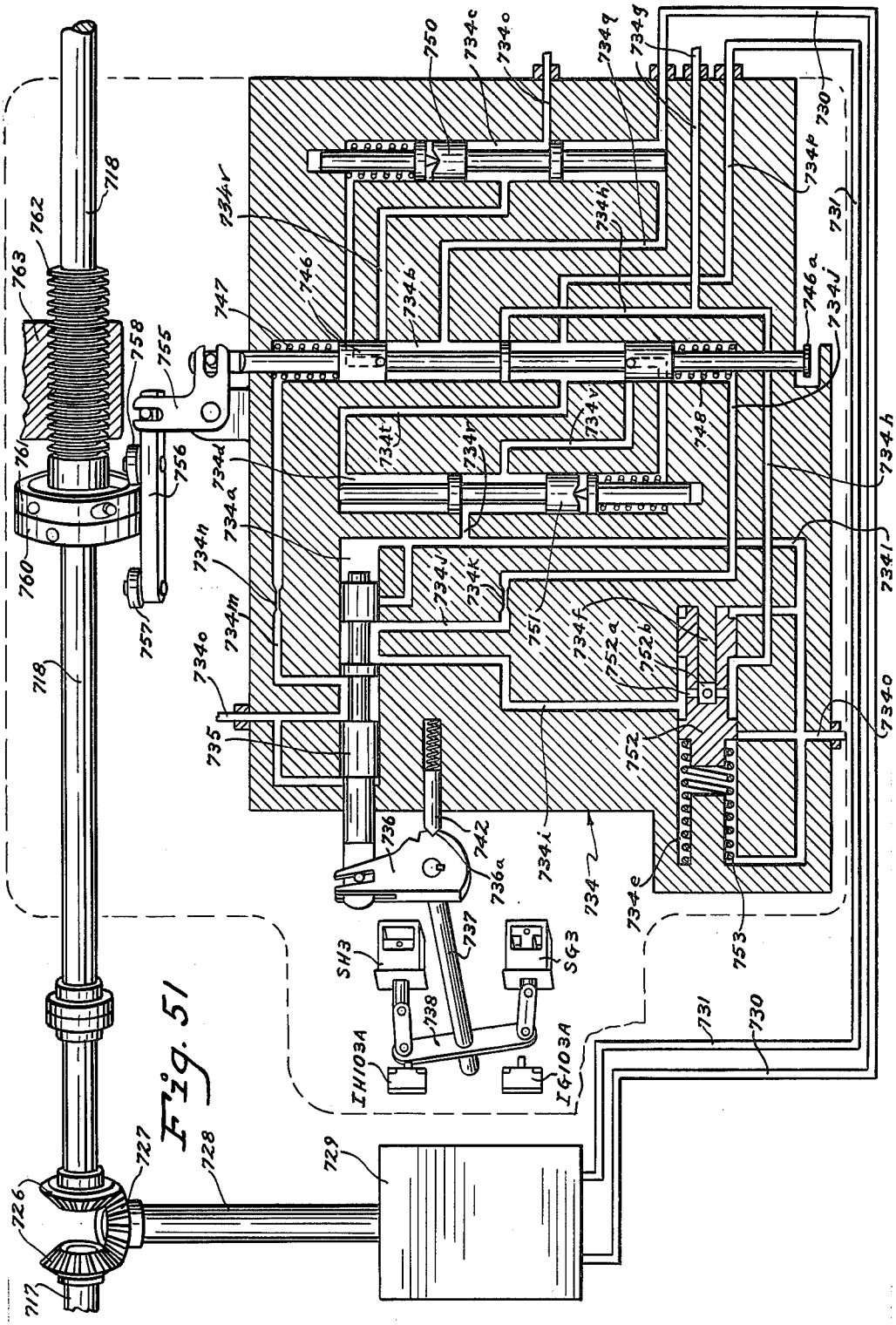


Fig. 51

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 38

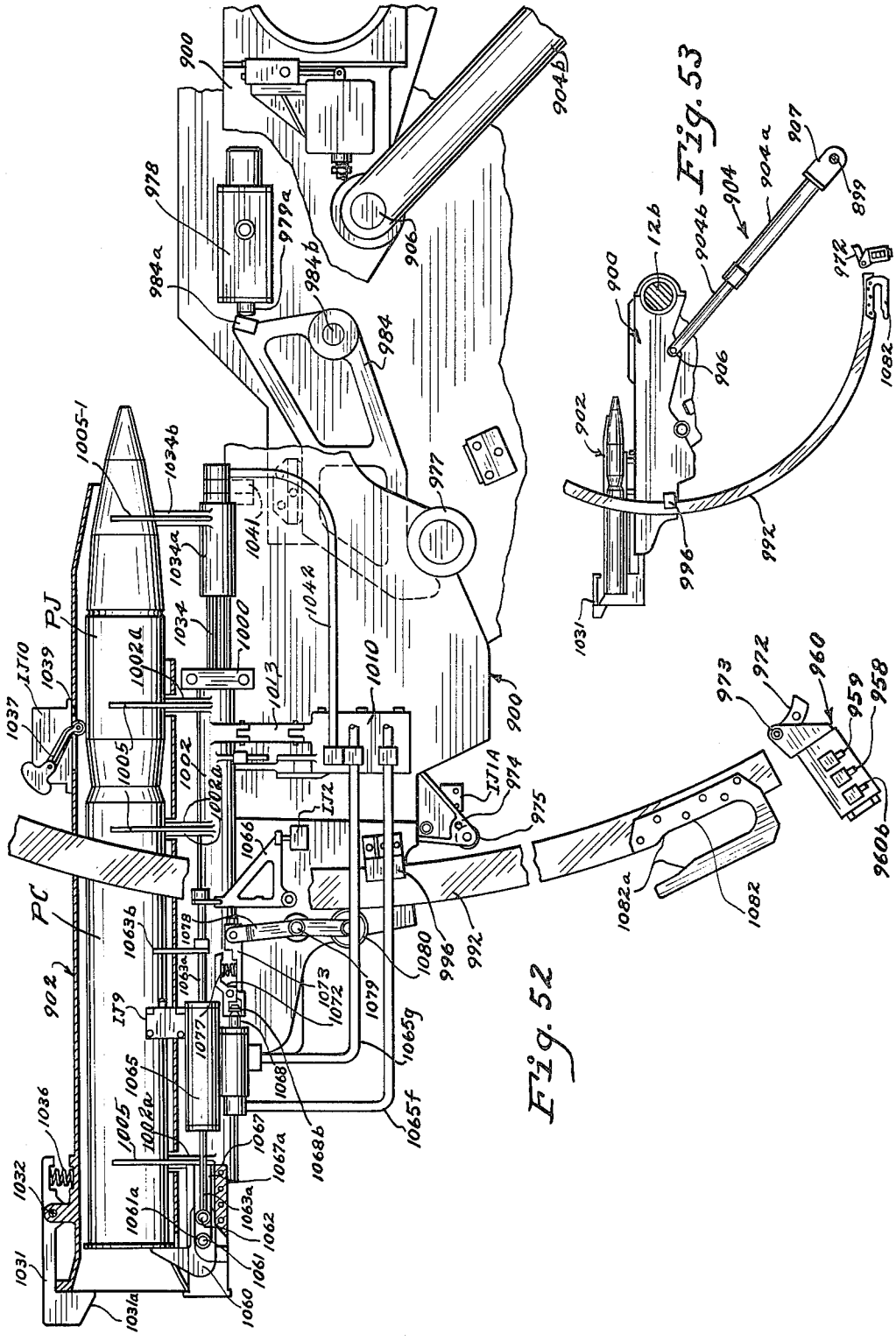


Fig. 52

Fig. 53

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 39

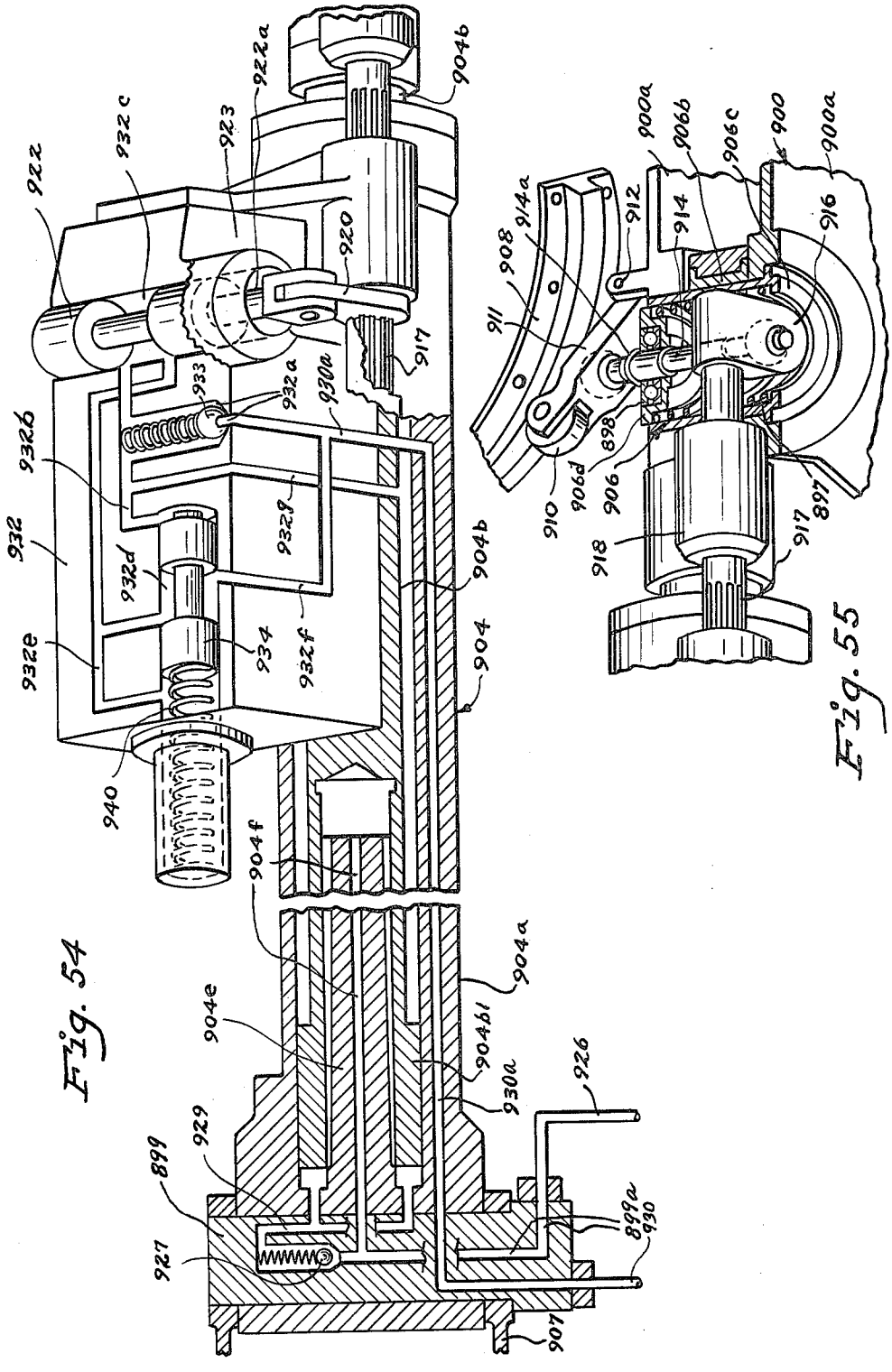


Fig. 54

Fig. 55

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 40

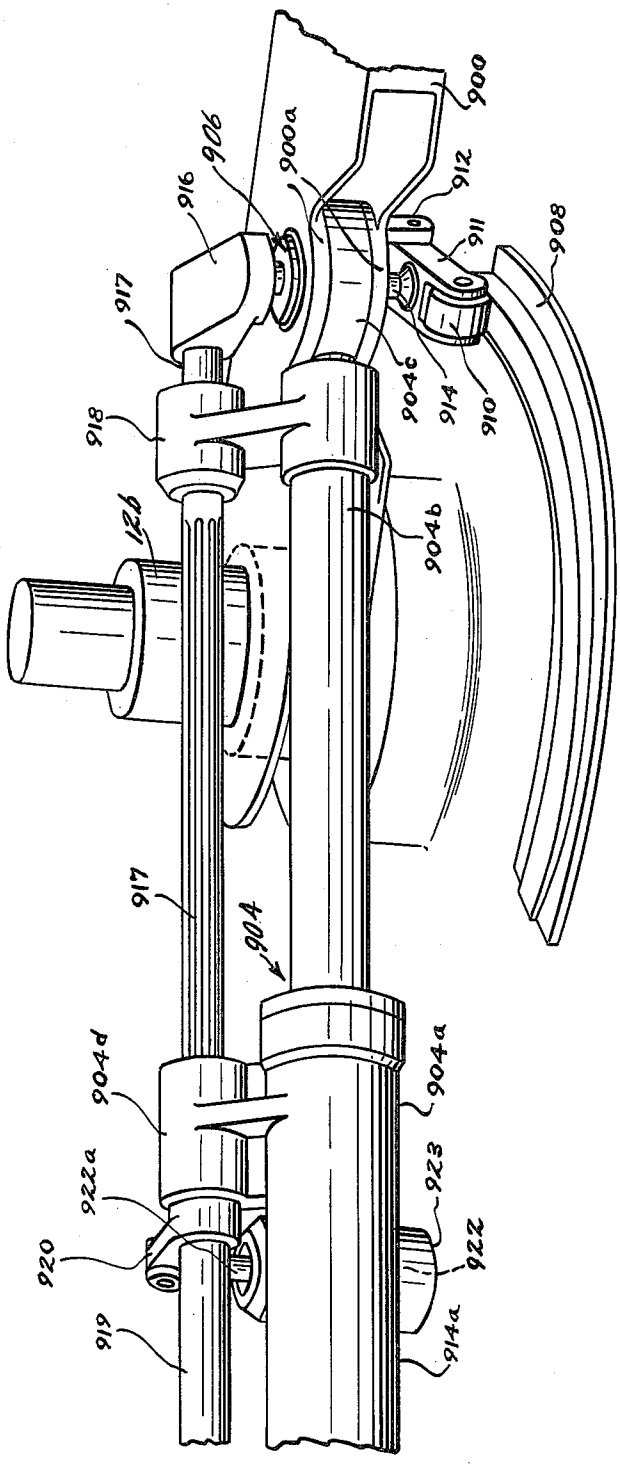


Fig. 56

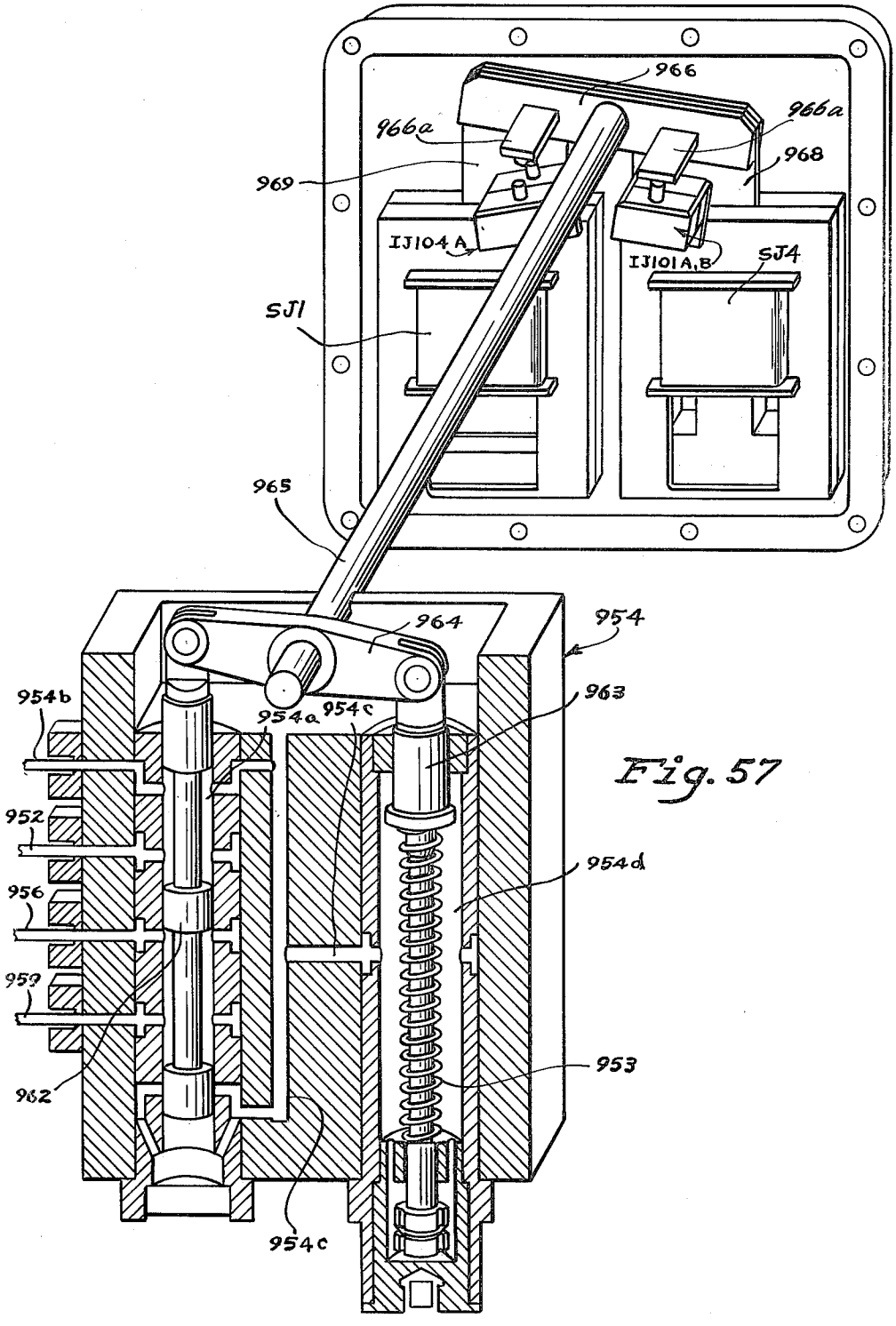

966
966a
966a
968
969
IJ104A
IJ101A,B
SJ4
SJ1
965
964
954
954b
954a
954c
963
952
956
959
982
954d
953
954c

Fig. 57

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 42

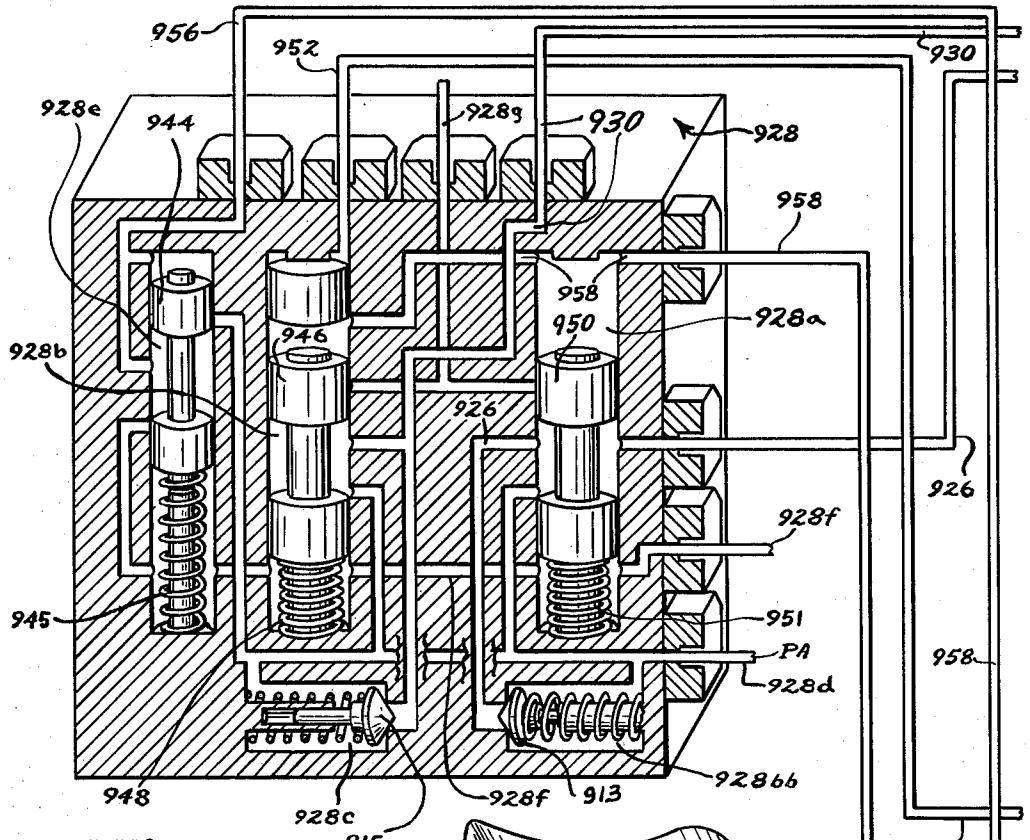


Fig. 58

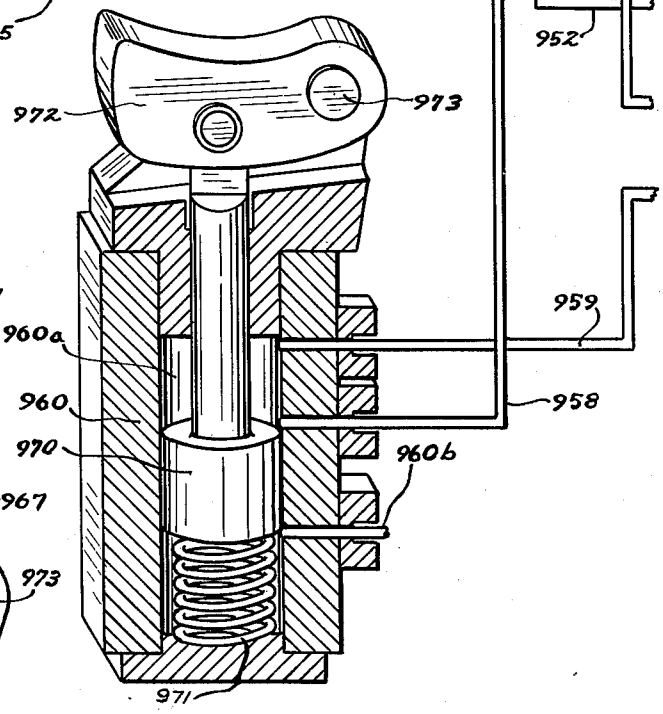
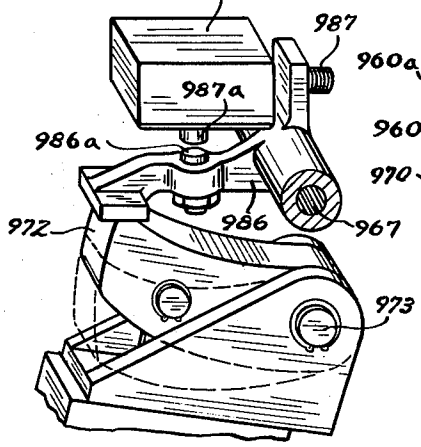


Fig. 59 IJIA



GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 43

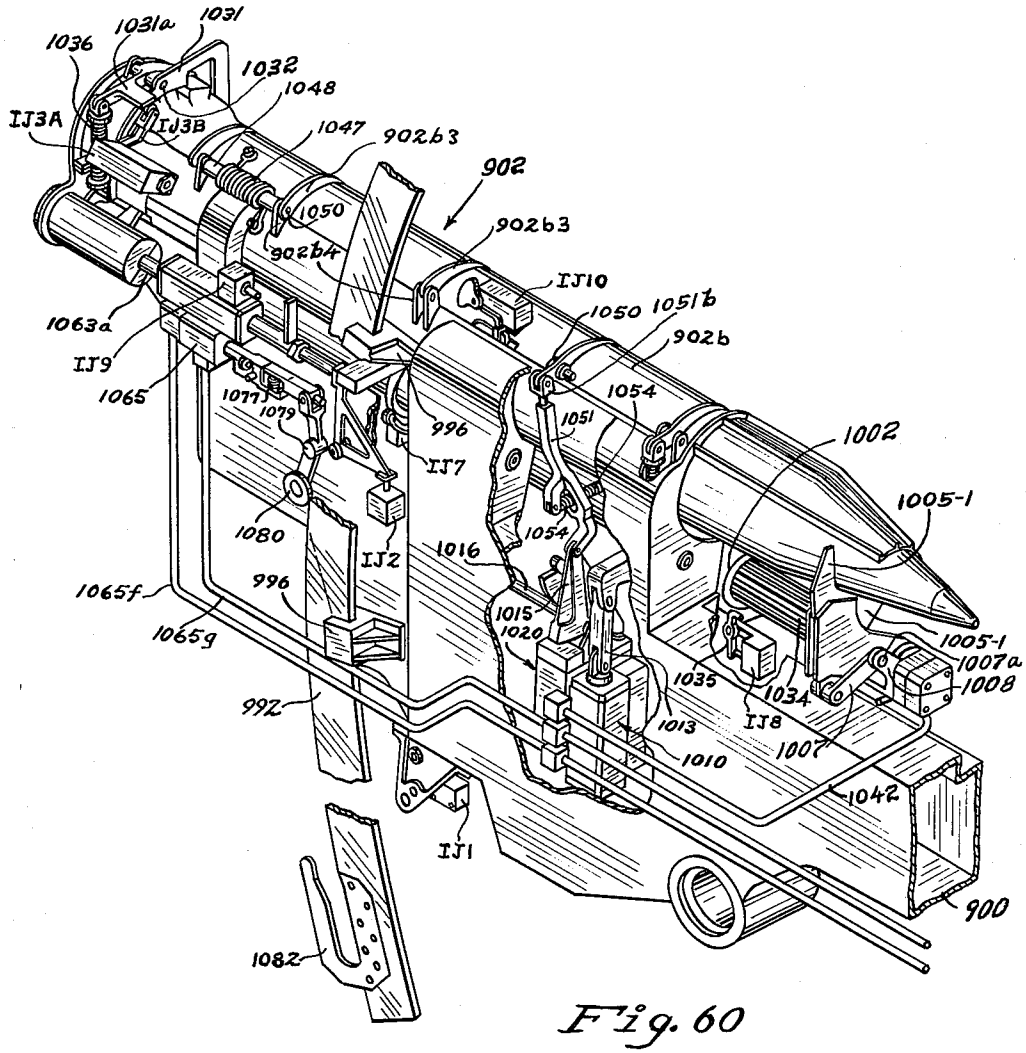


Fig. 60

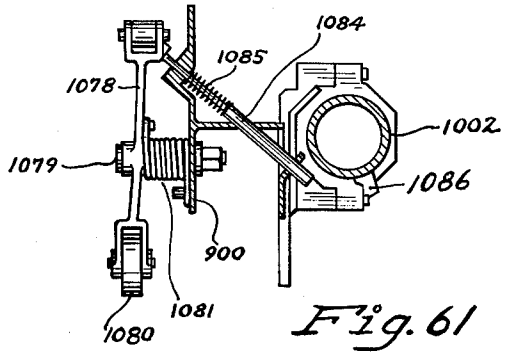


Fig. 61

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 44

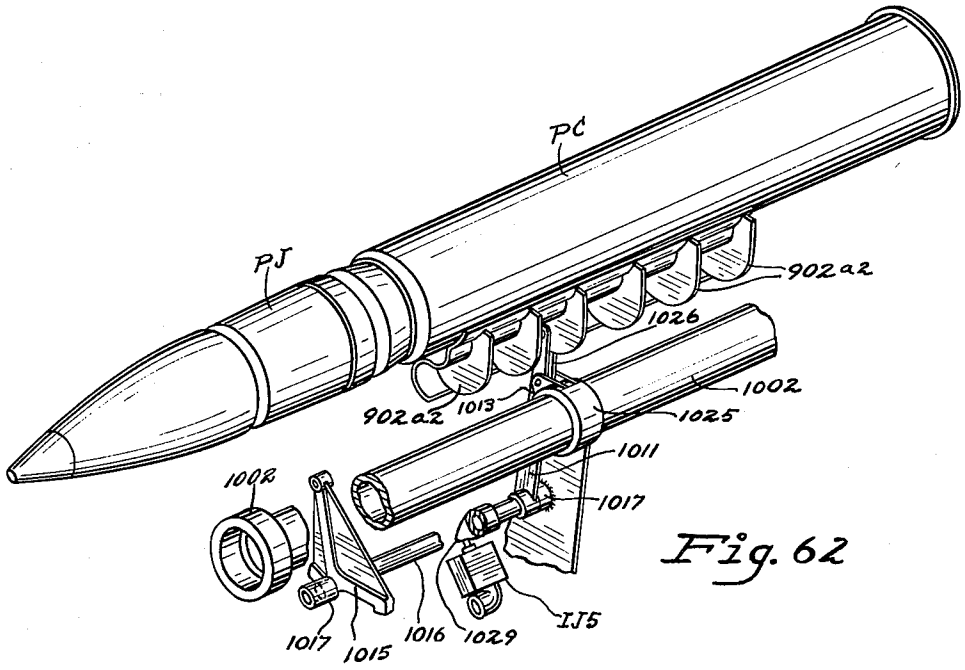


Fig. 62

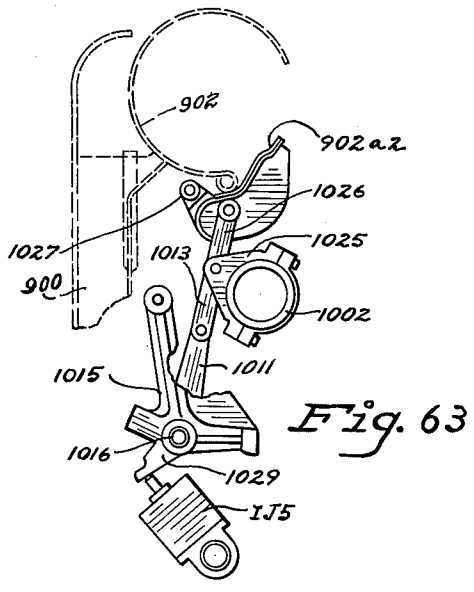


Fig. 63

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 45

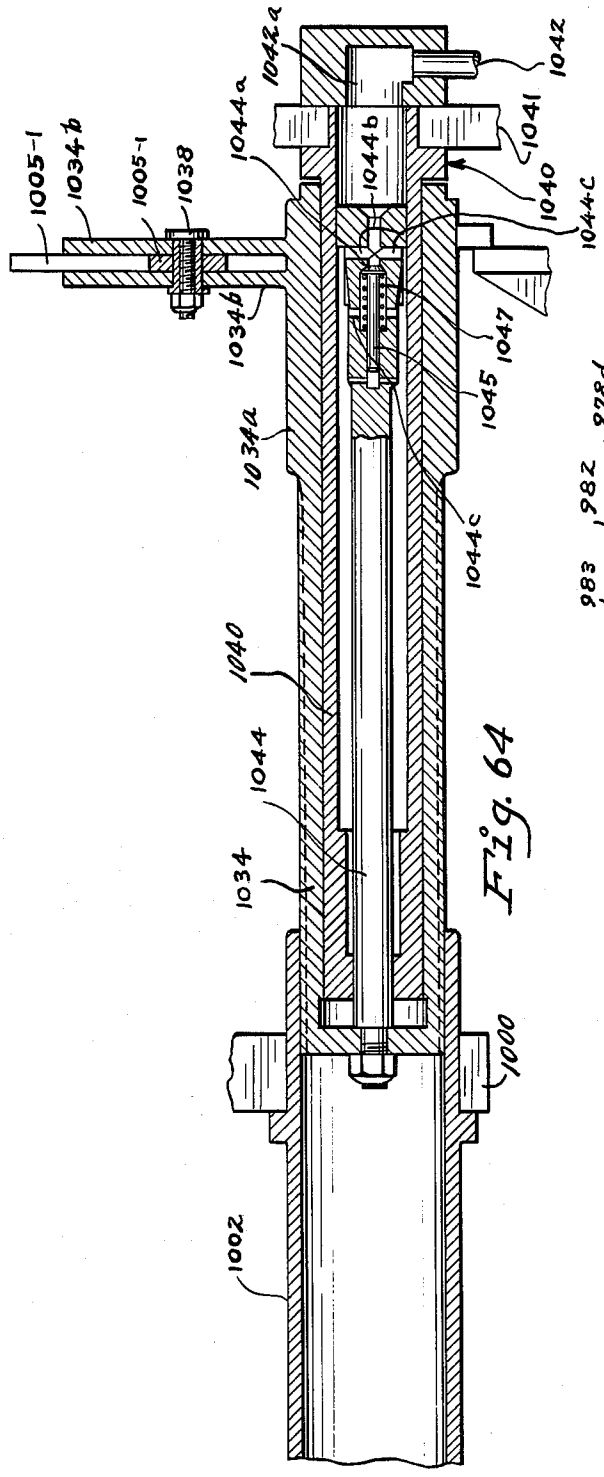


Fig. 64

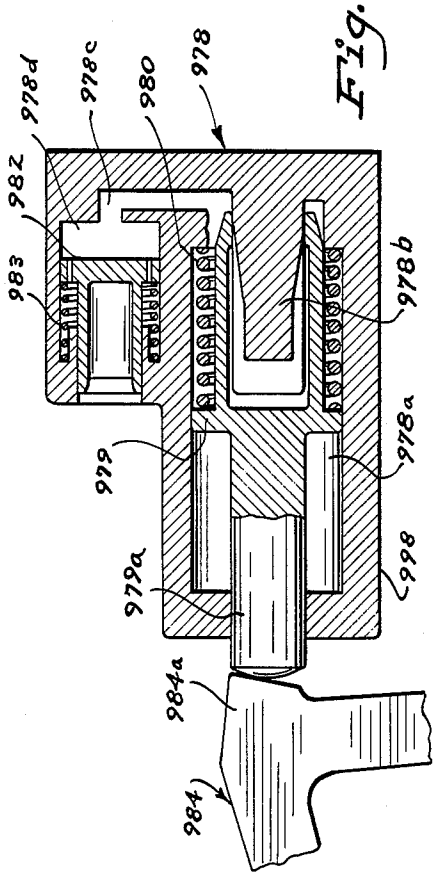


Fig. 65

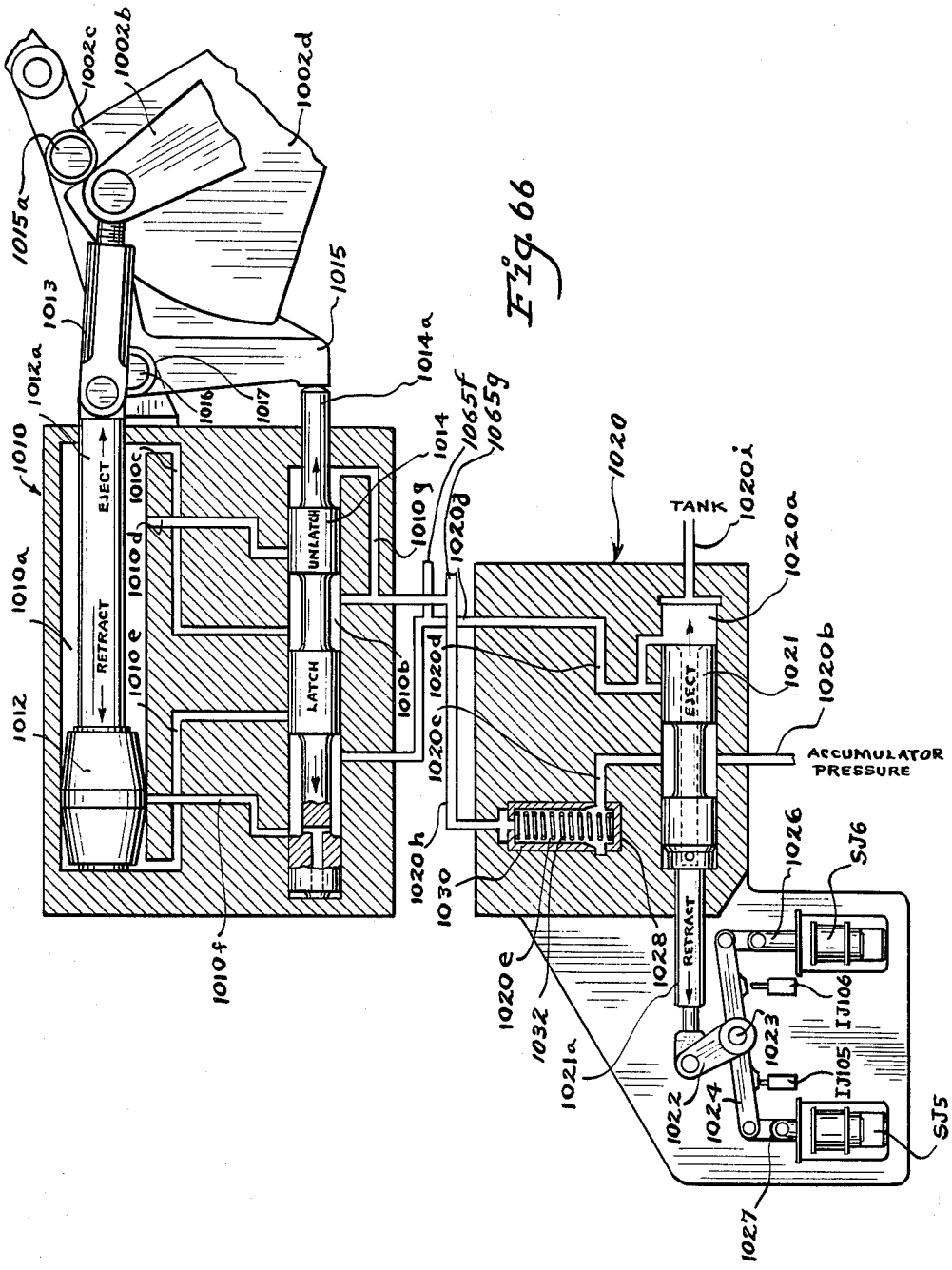

1002c
1002b
1002d
1015a
1013
1015
1012a
1014a
1016
1017
1010
1014
1065f
1065g
1020
1010a
1010c
1010d
1010e
1010g
1020d
TANK
1020i
1020a
1021
1020b
1012
1010b
1020c
ACCUMULATOR PRESSURE
1020h
1030
1026
SJ6
1010f
1020e
1028
1032
1021a
IJ106
1023
IJ105
1022
1024
SJ5
1027
EJECT
RETRACT
UNLATCH
LATCH

Fig. 66

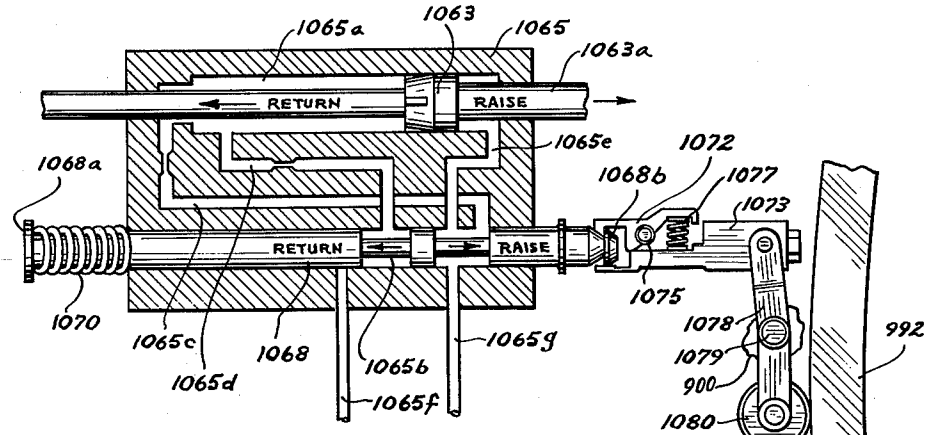

1065a
1063
1065
1063a
RETURN
RAISE
1065e
1072
1068a
1068b
1077
1073
RETURN
RAISE
1075
1070
1065c
1068
1065g
1078
992
1065d
1065b
1079
900
1065f
1080

Fig. 67

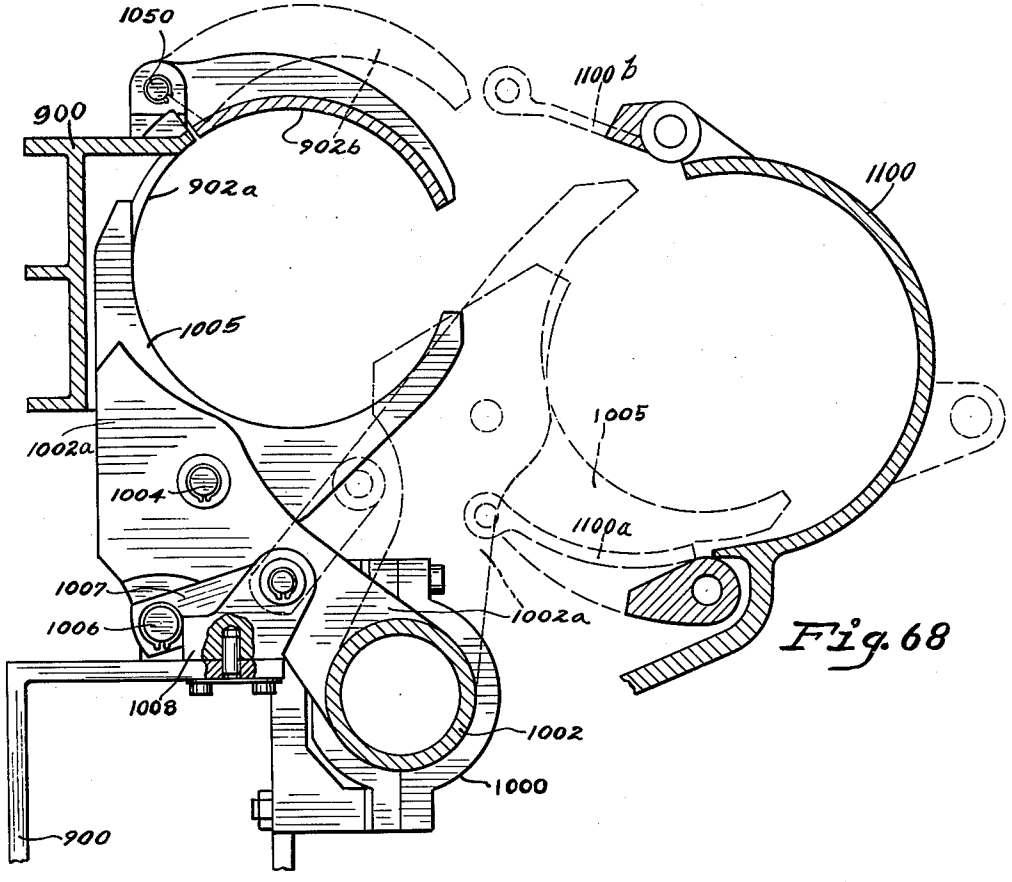

1050
1100b
900
902b
1100
902a
1005
1005
1002a
1004
1100a
1007
1002a
1006
1008
1002
1000
900

Fig. 68

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 48

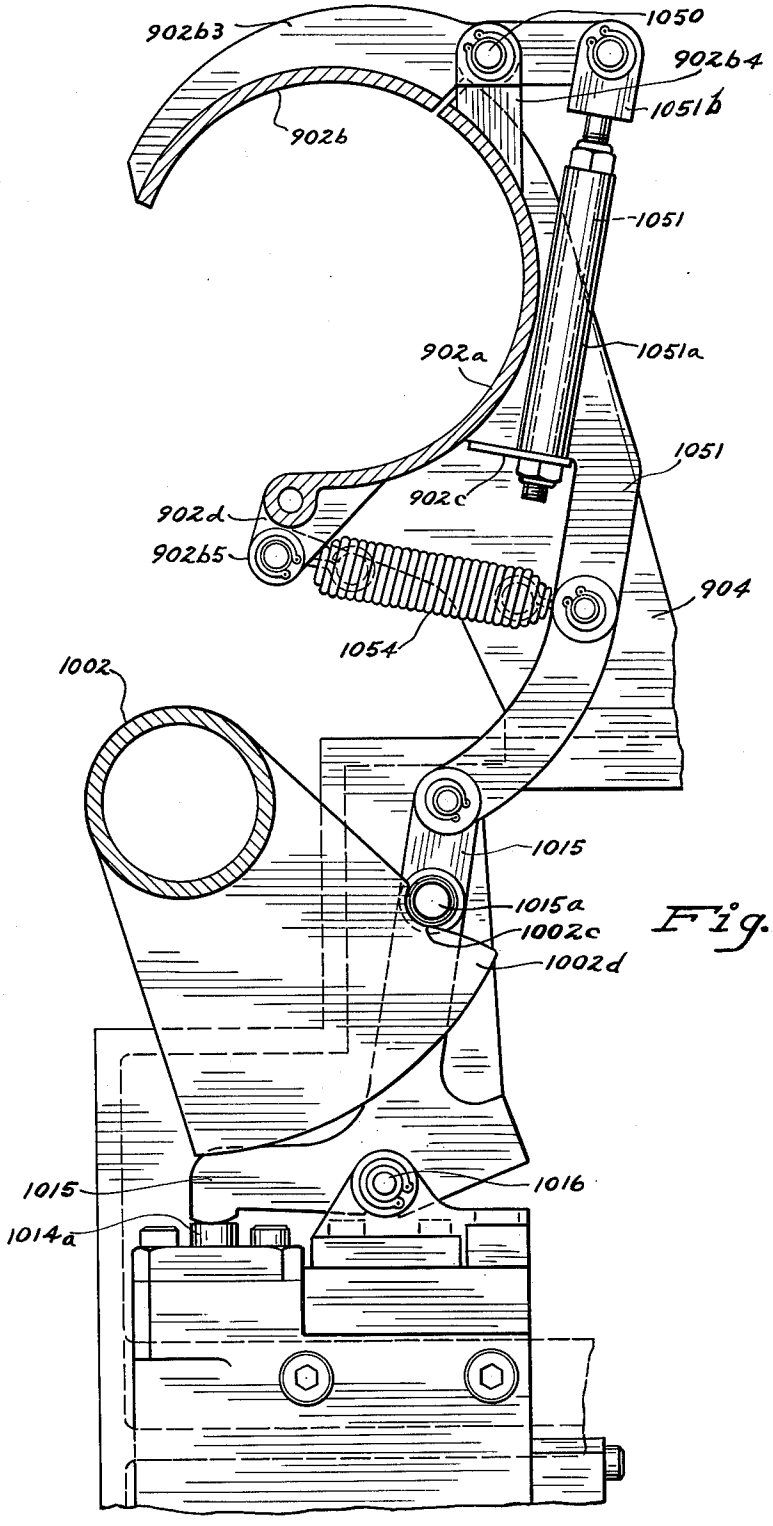


Fig. 69

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 49

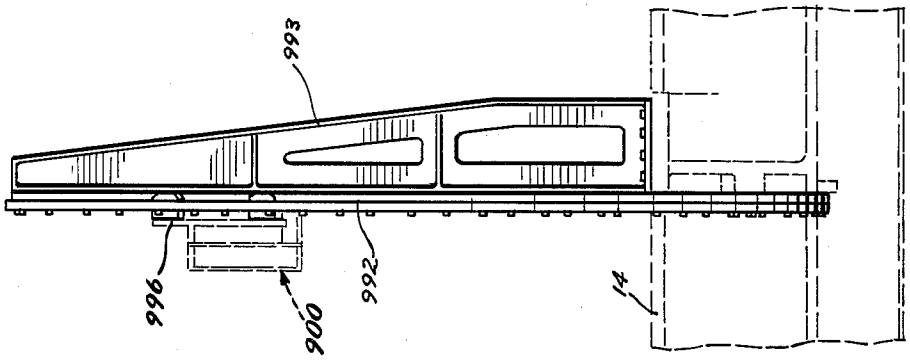


Fig. 71

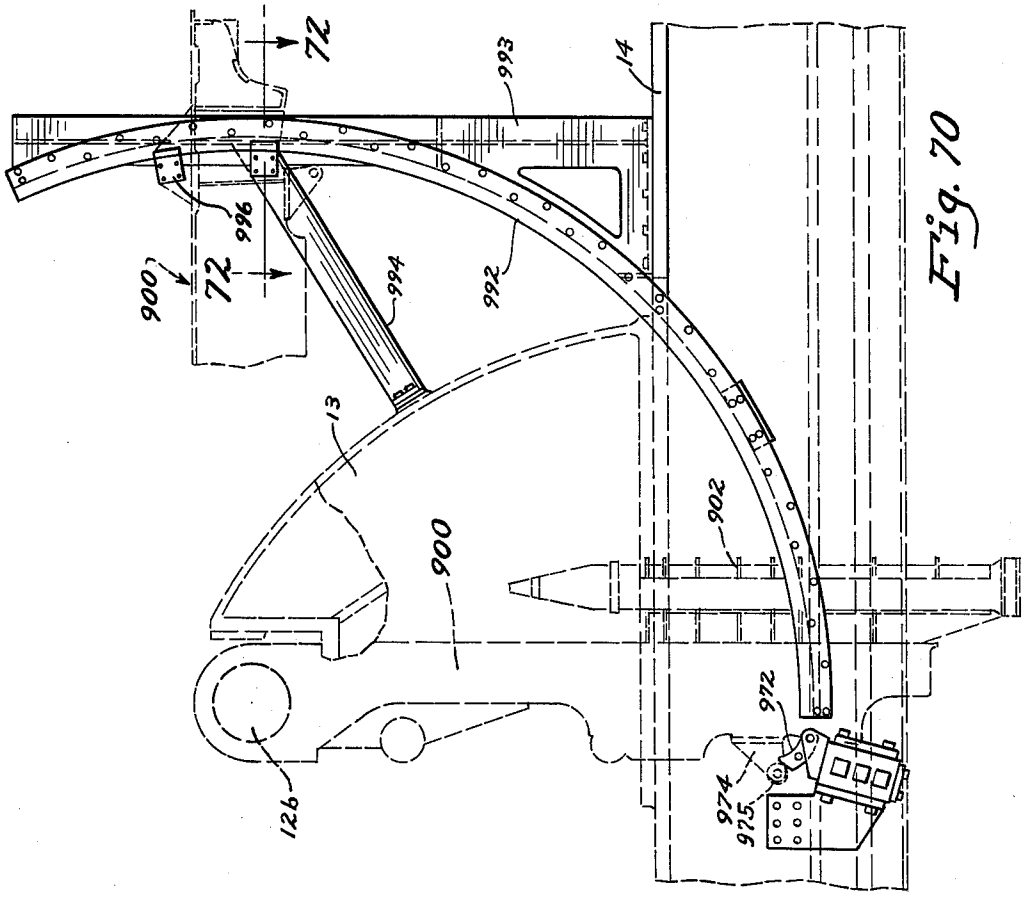


Fig. 70

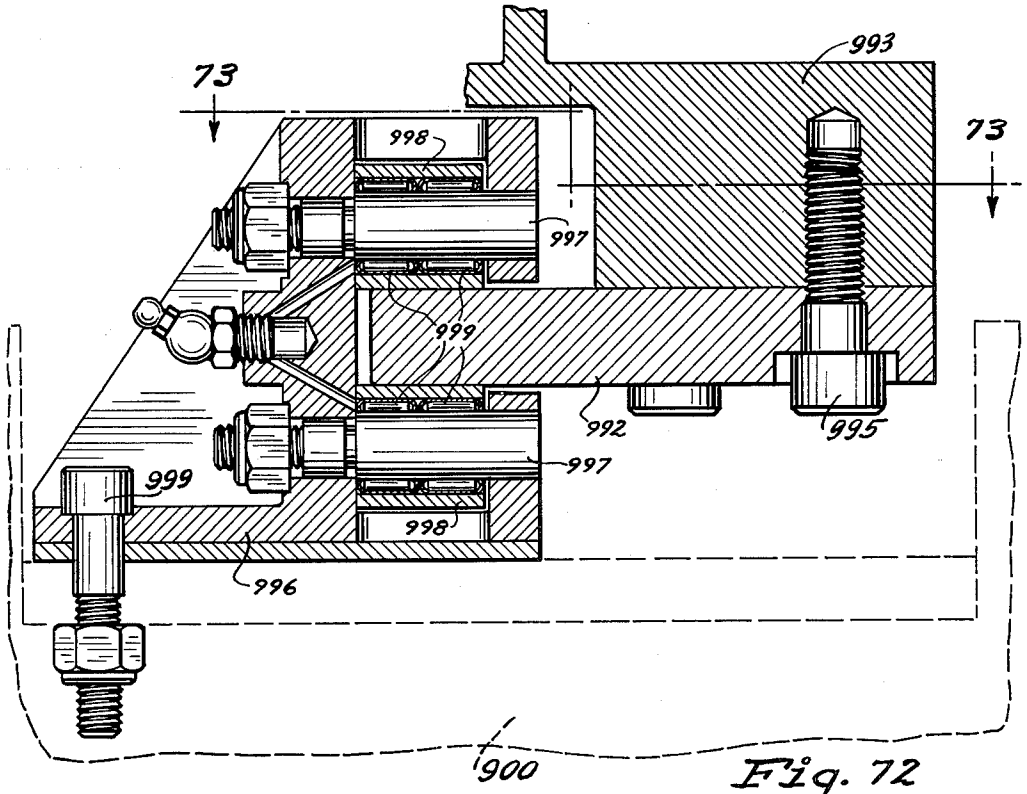

73
993
73
998
997
999
992
995
997
999
998
996
900

Fig. 72

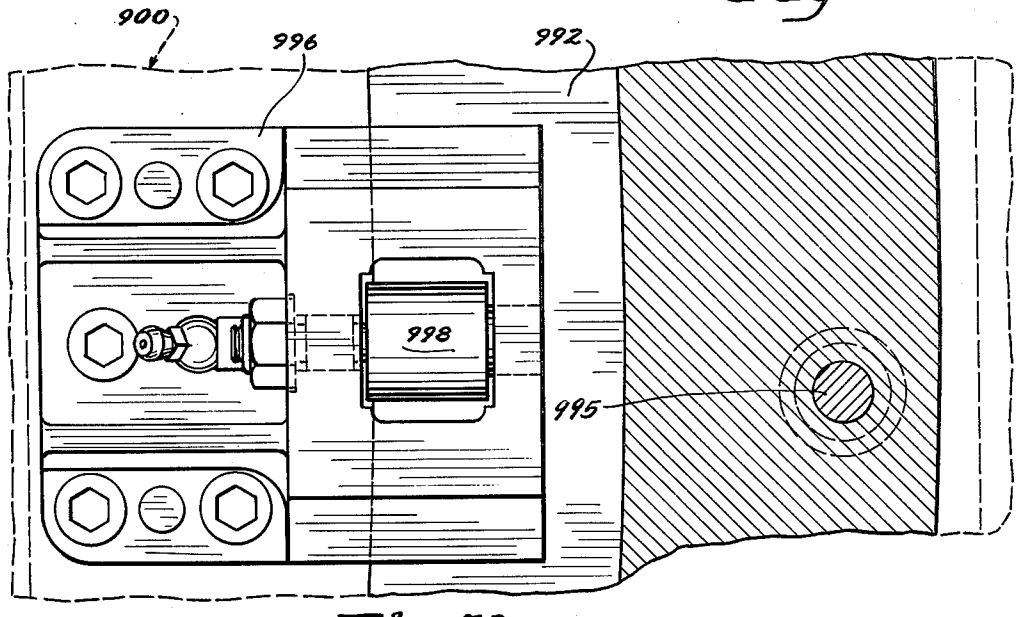

900
996
992
998
995

Fig. 73

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 51

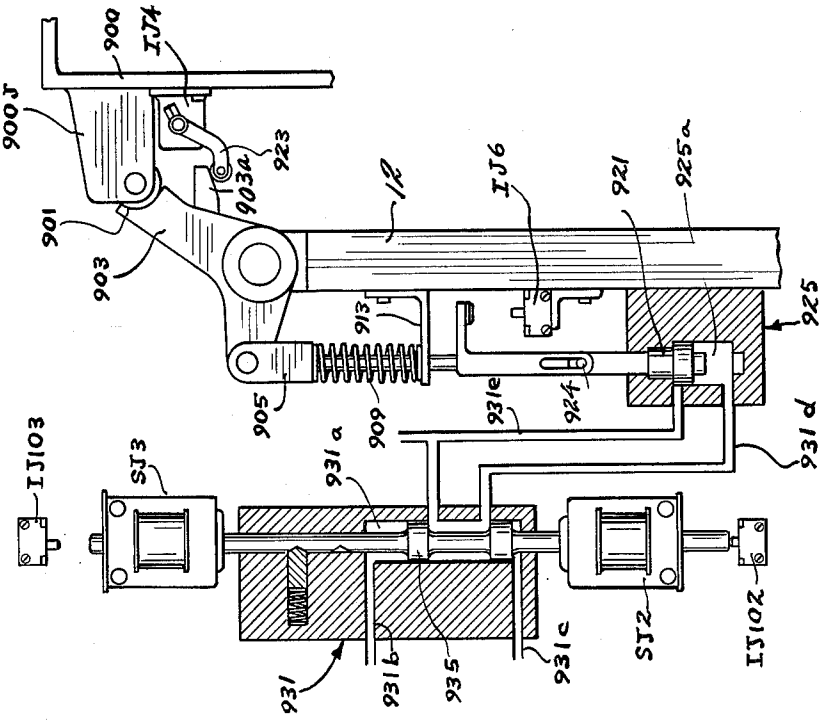


Fig. 75

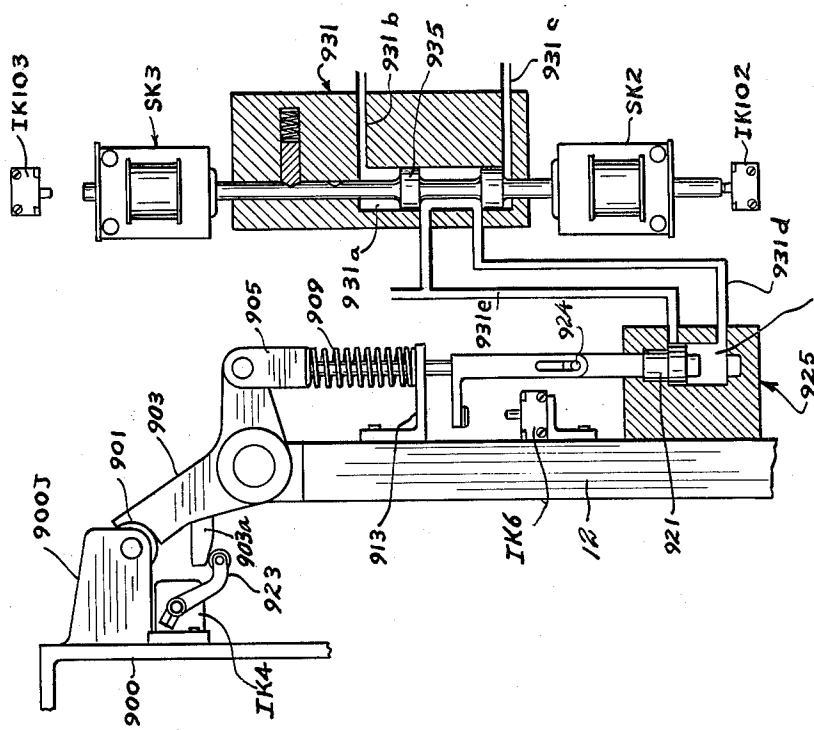


Fig. 74

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 52

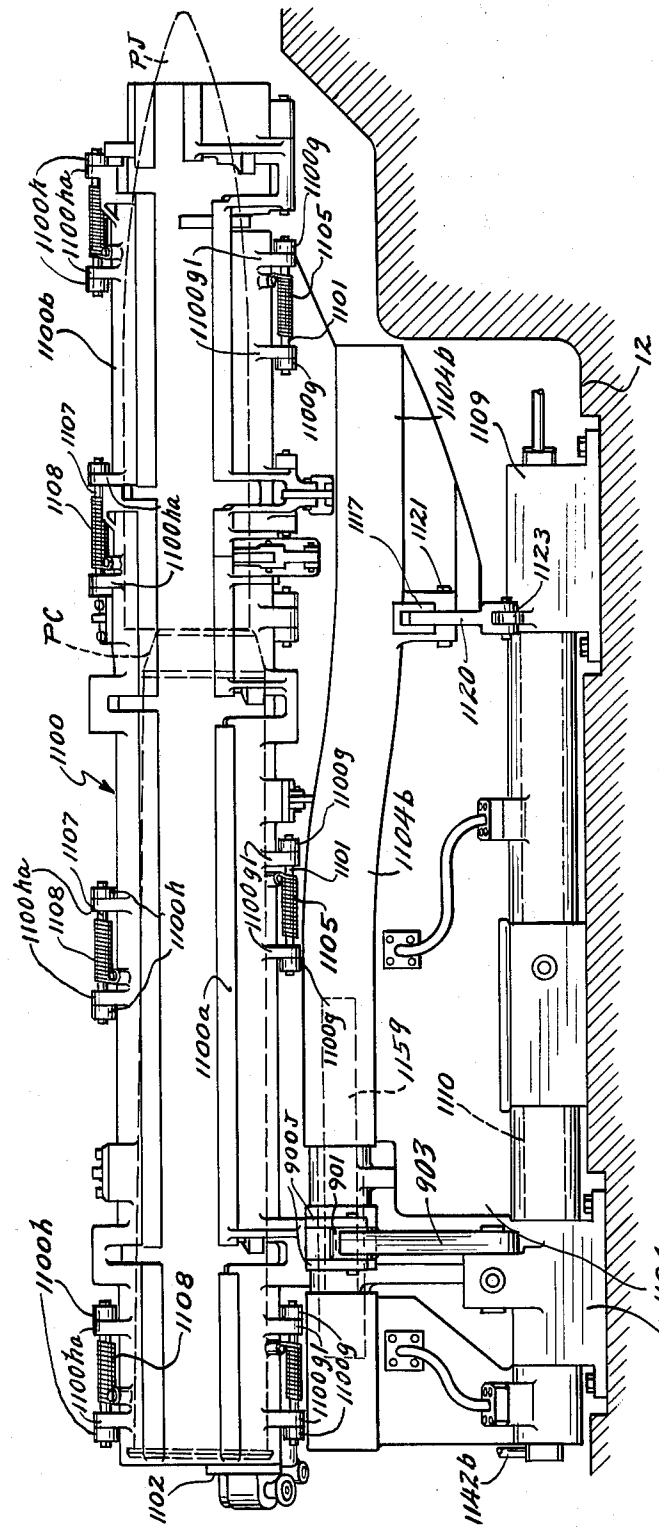


Fig. 76

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 53

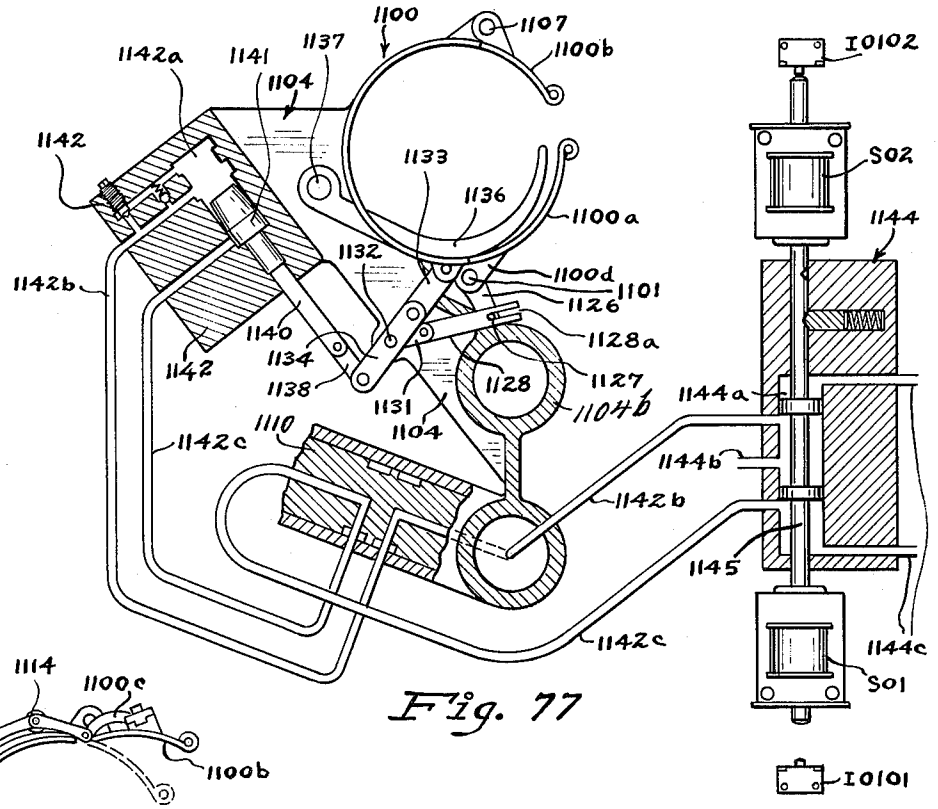


Fig. 77

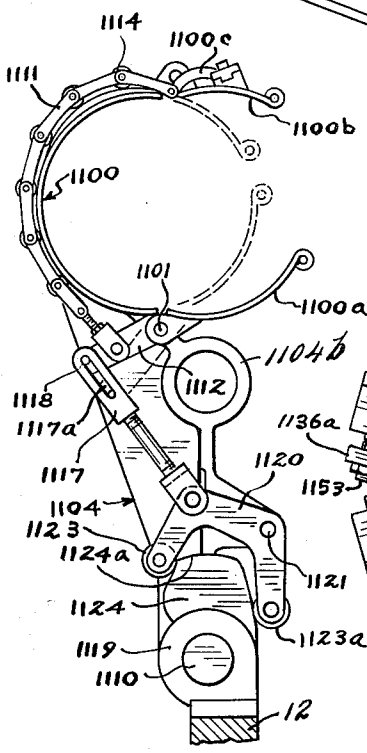


Fig. 78

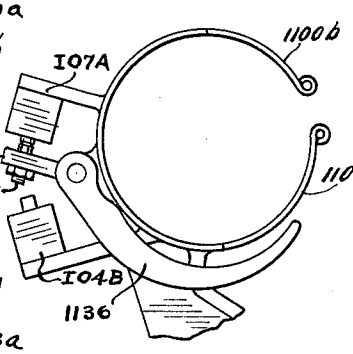


Fig. 79

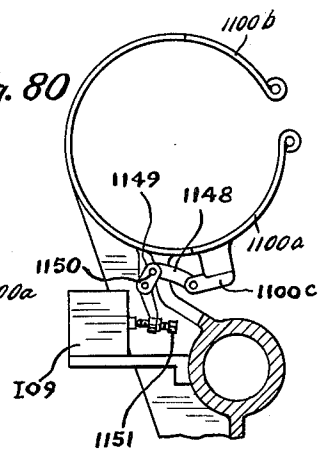


Fig. 80

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930
GUN MOUNT WITH AMMUNITION SUPPLYING MEANS
Filed Aug. 27, 1952 76 Sheets-Sheet 54

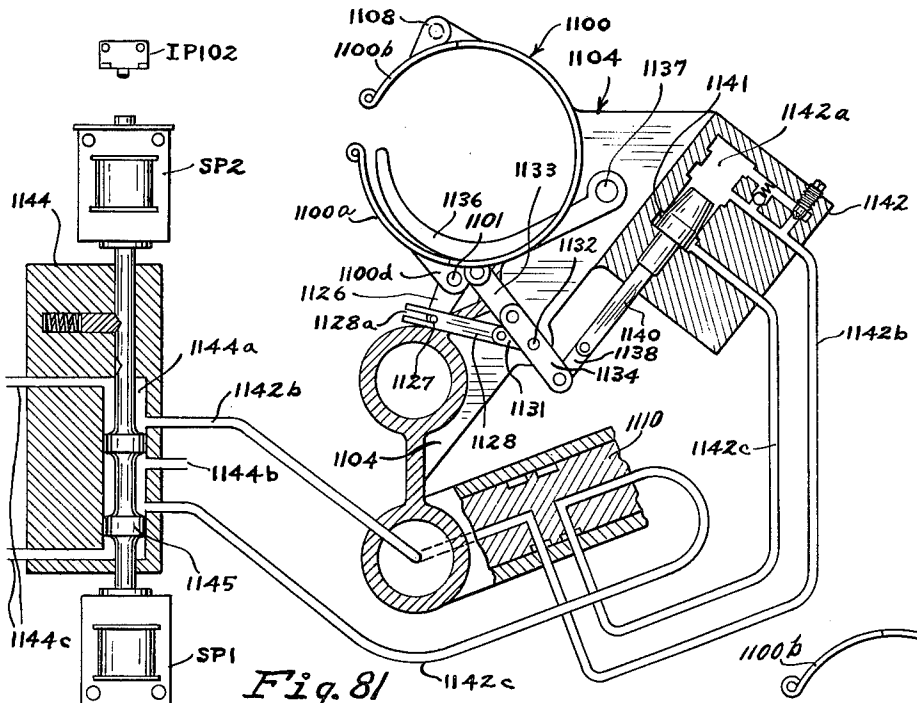


Fig. 81

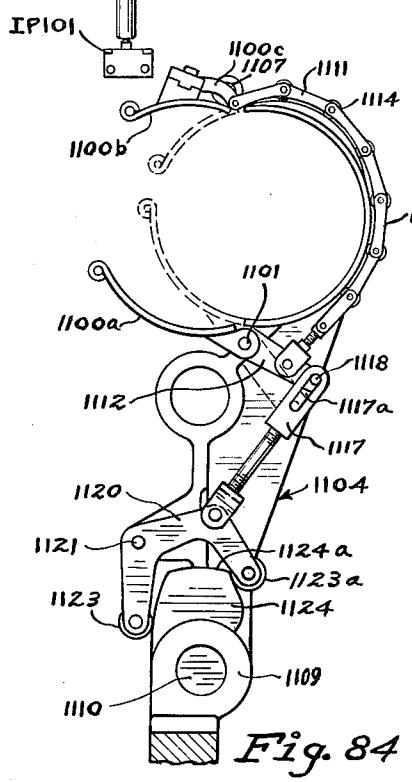


Fig. 84

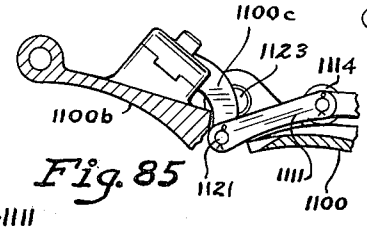


Fig. 85

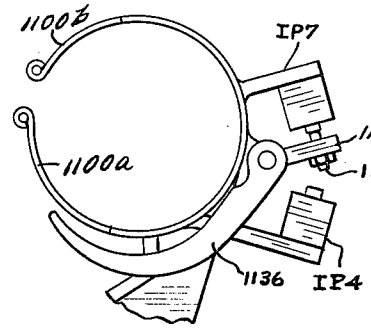


Fig. 83

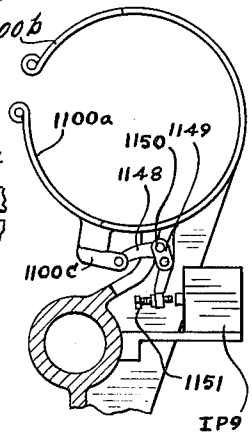


Fig. 82

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 55

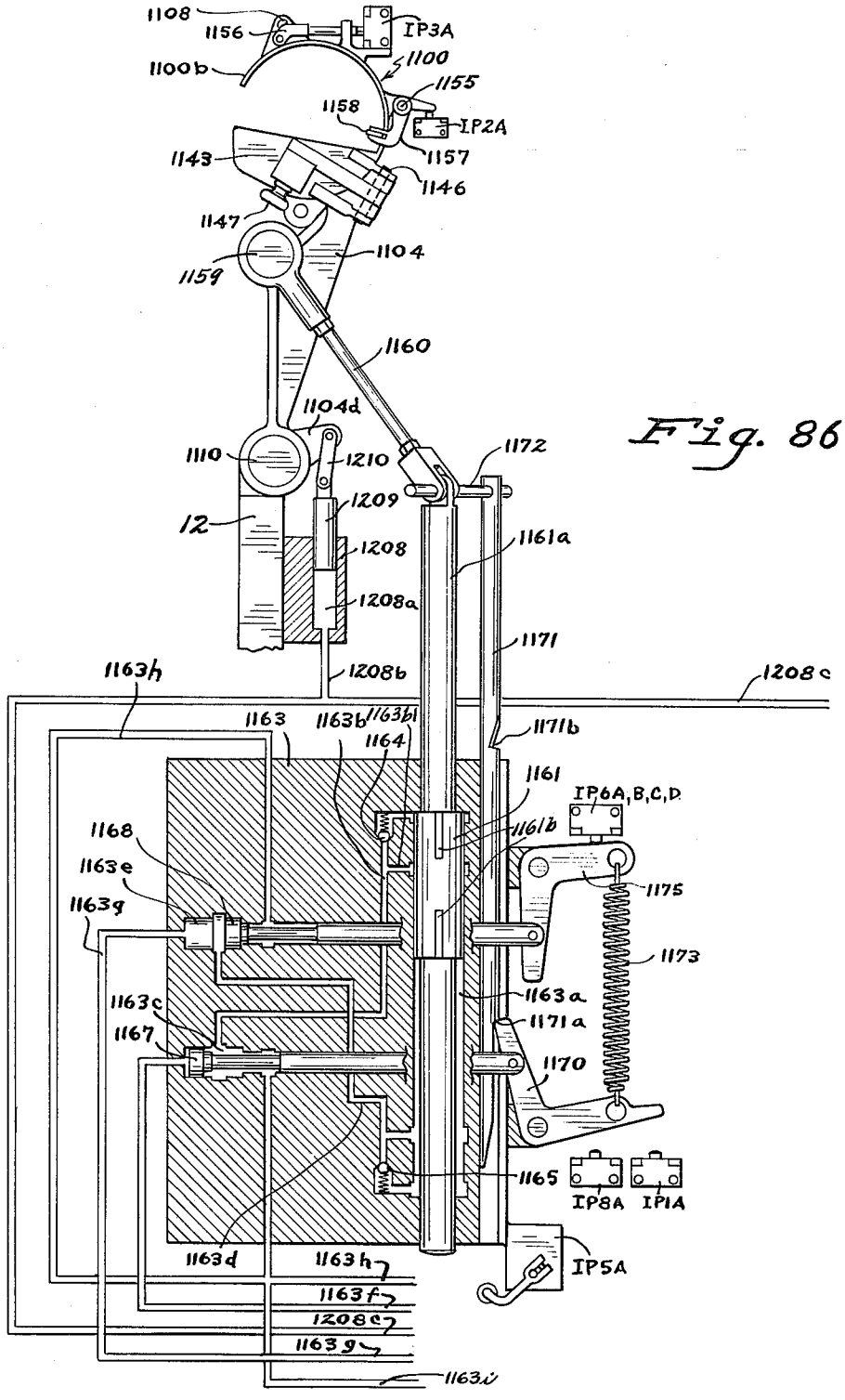


Fig. 86

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 56

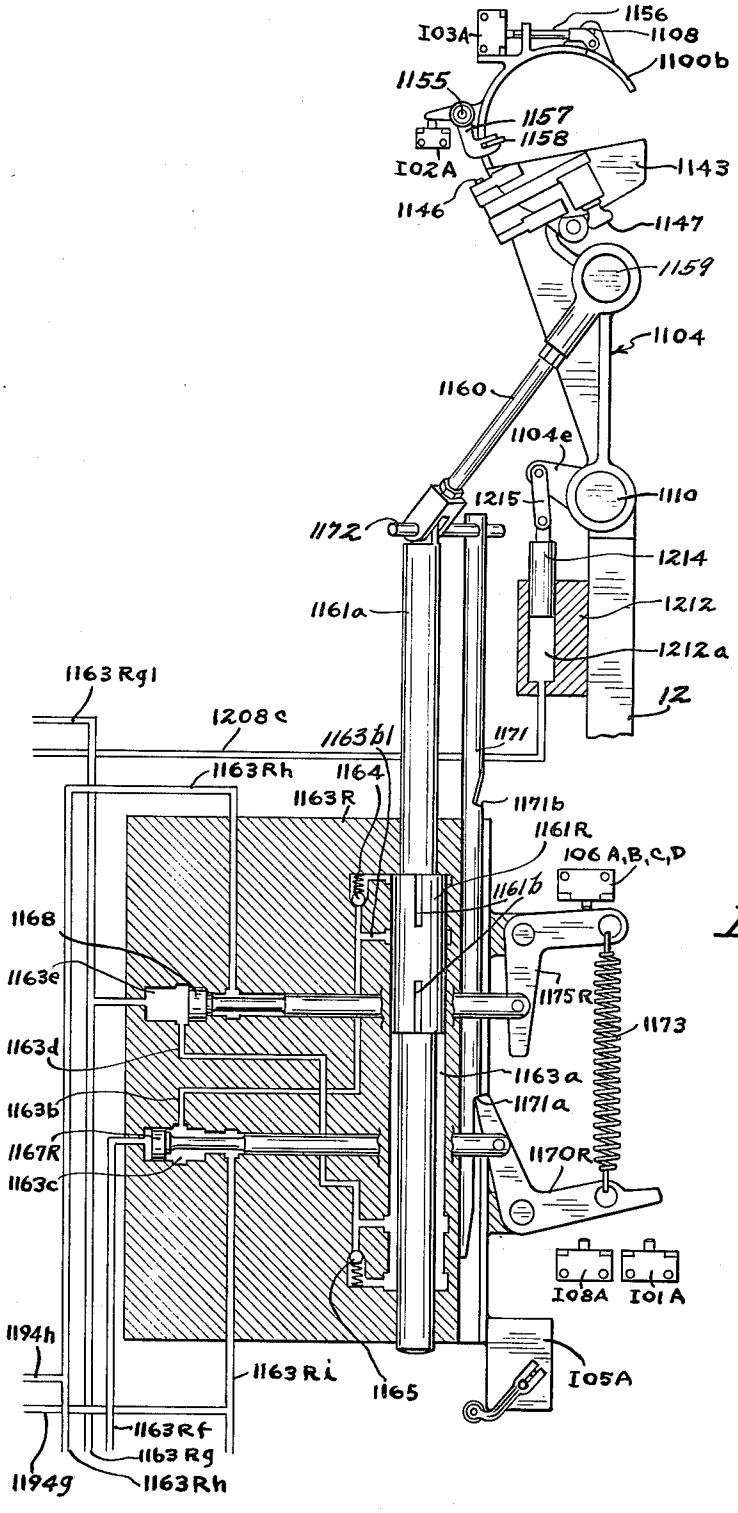


Fig. 87

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 57

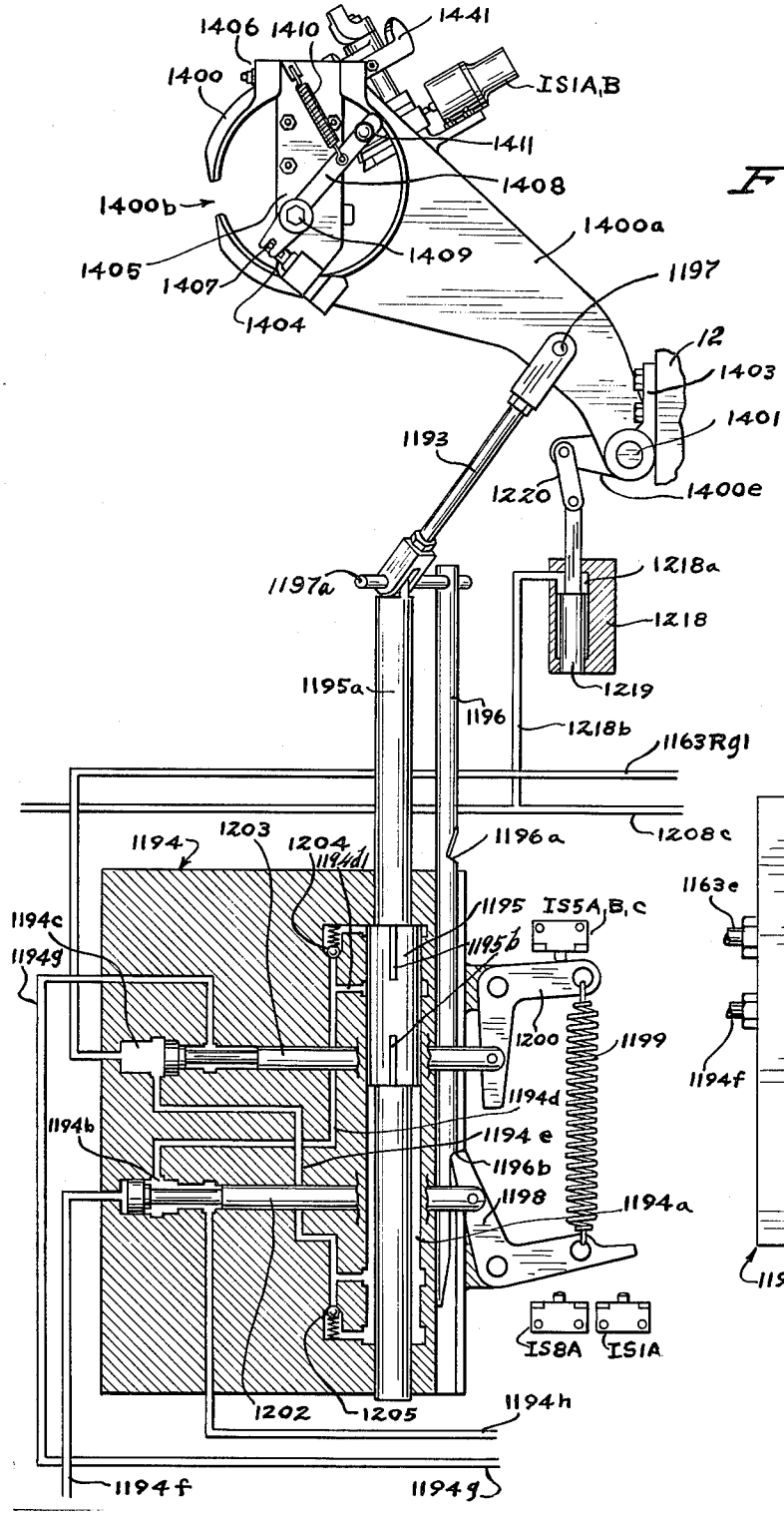


Fig. 89

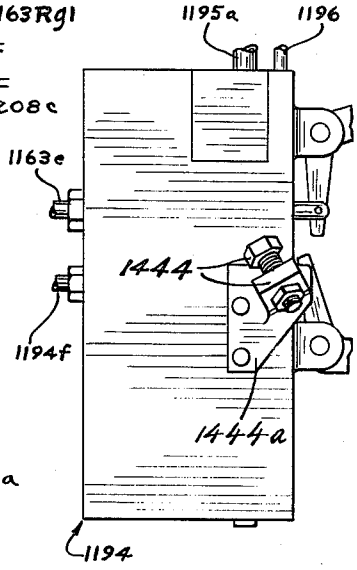


Fig. 88

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 58

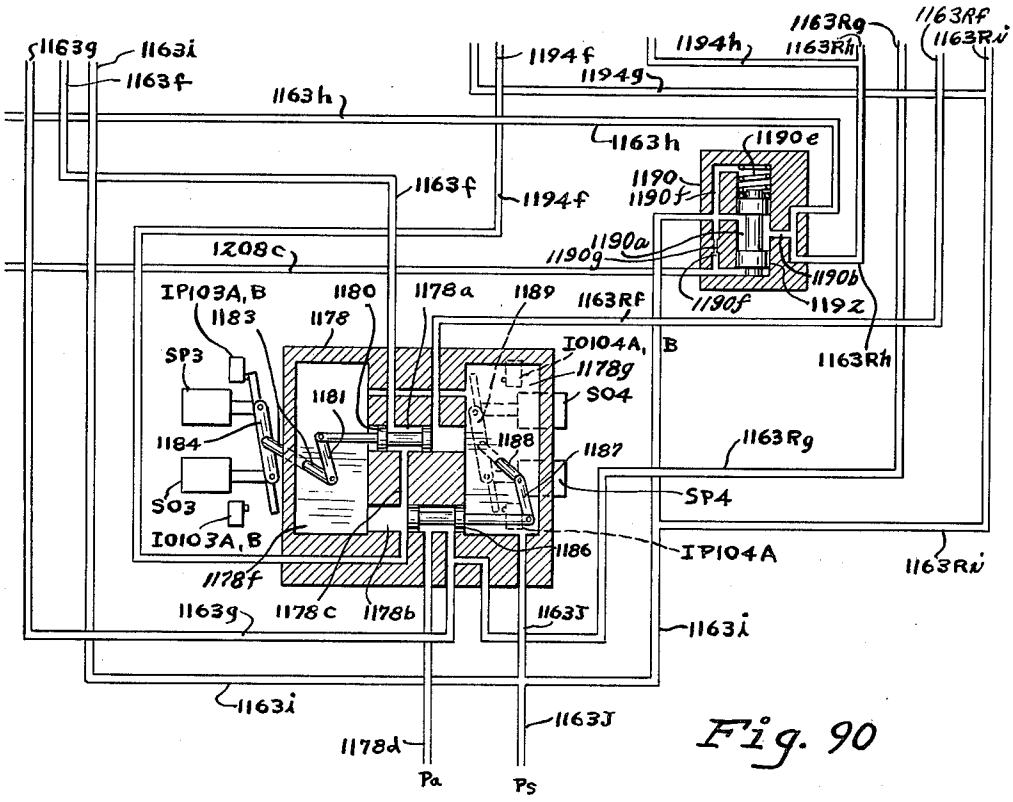


Fig. 90

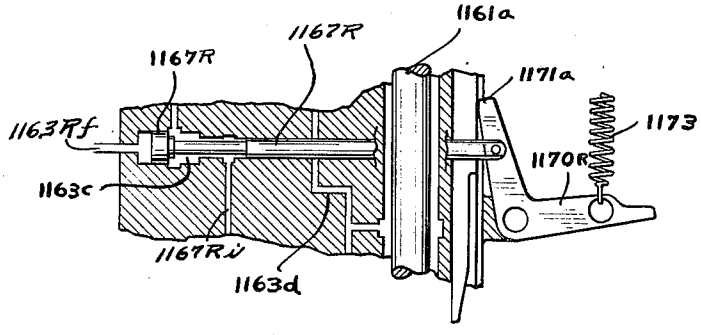


Fig. 91

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 59

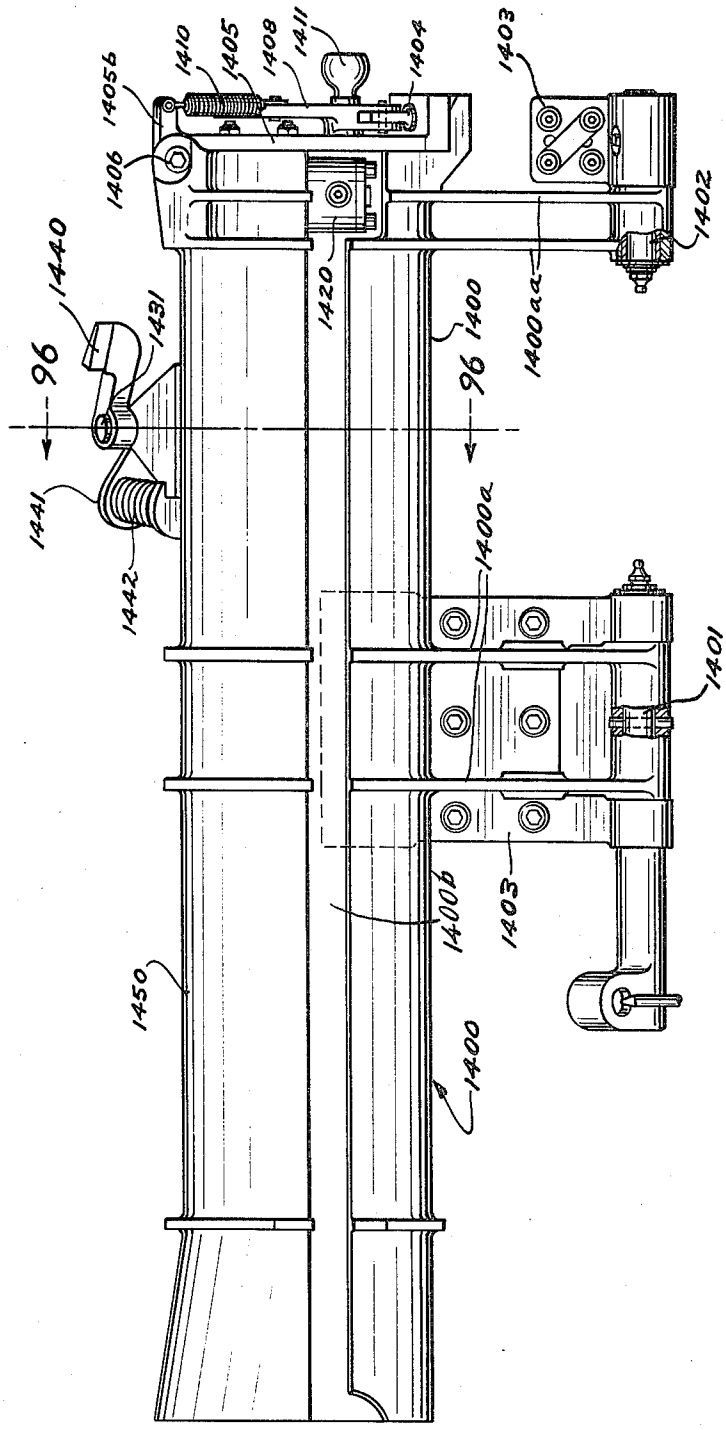
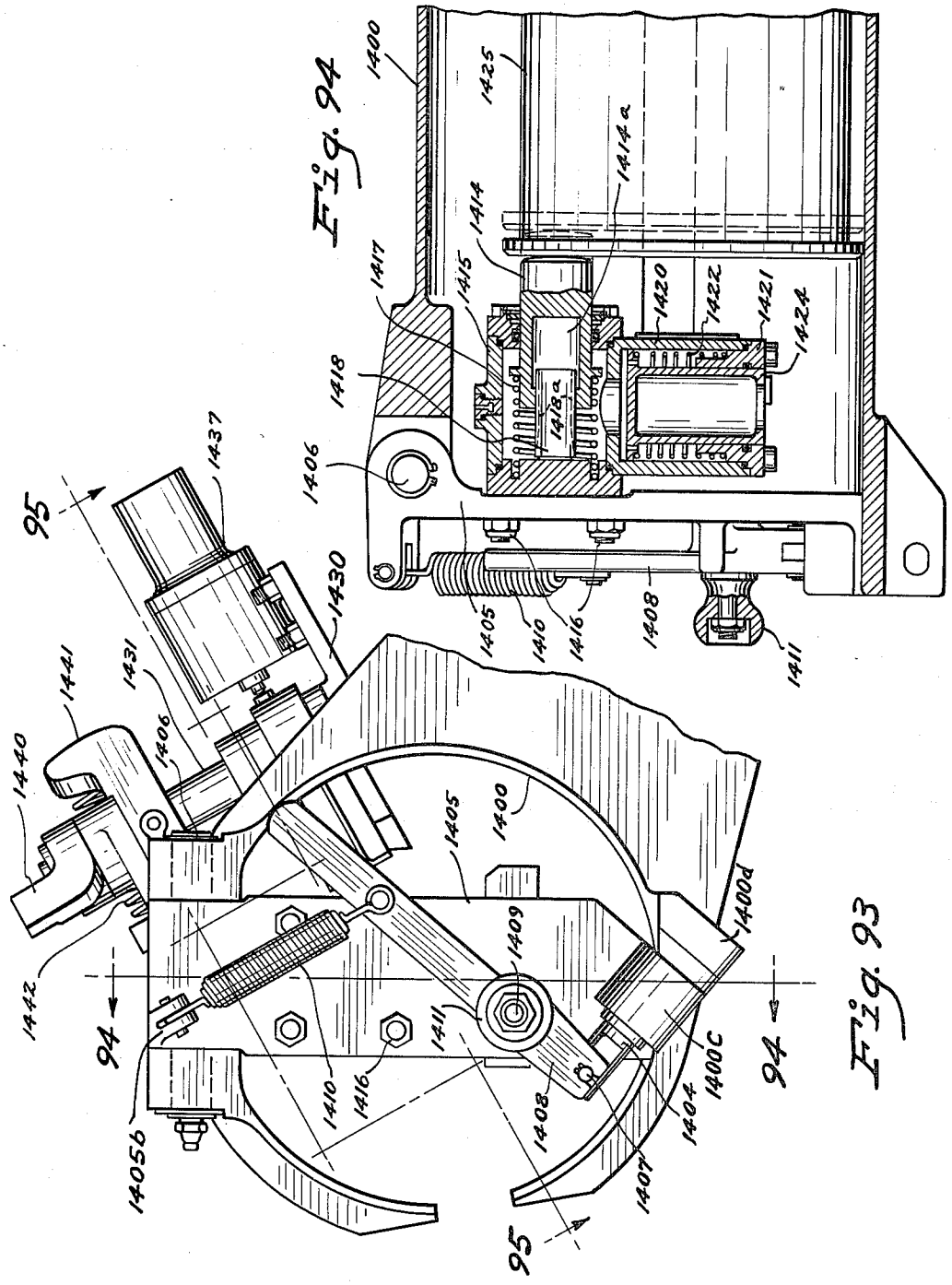


Fig. 92


1400
1425
1414a
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1422
1421
1424
1418
1418a
1406
1405
1410
1416
1408
1411
1430
1437
1431
1441
1440
1442
1409
1400d
1400c
1404
1407
1400b
95
94

Fig. 94

Fig. 93

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 61

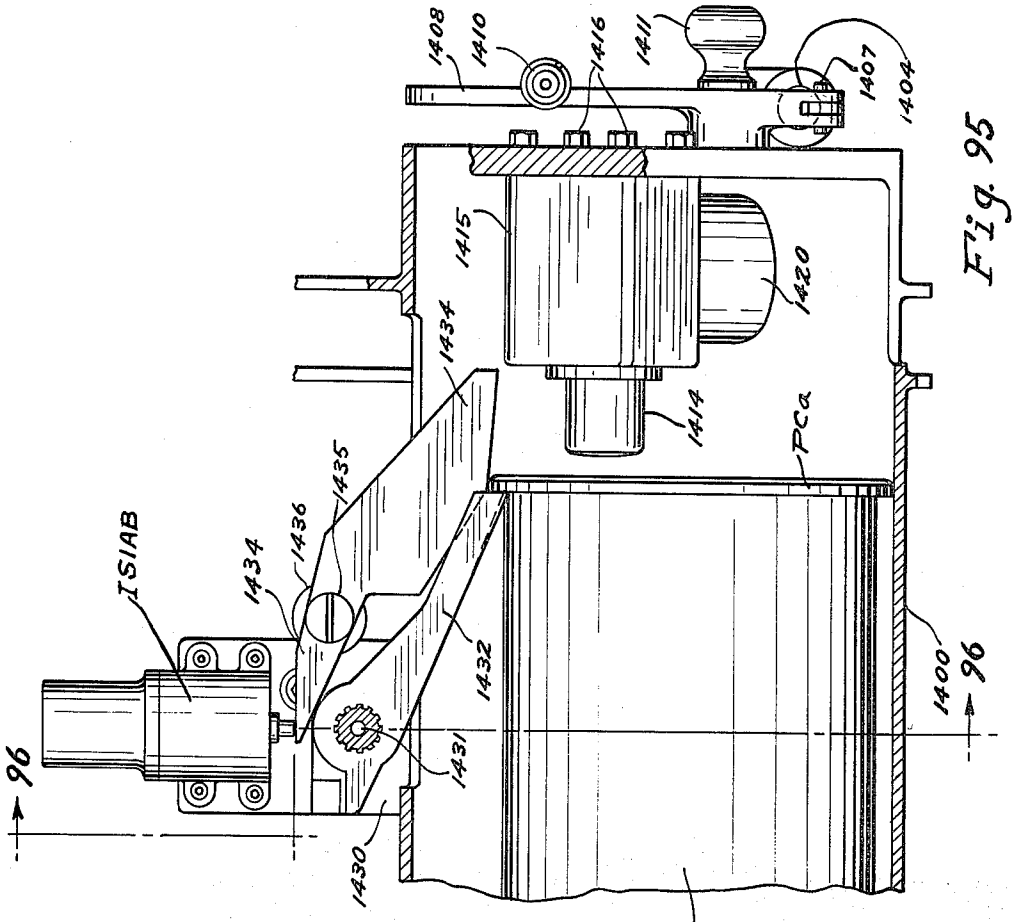


Fig. 95

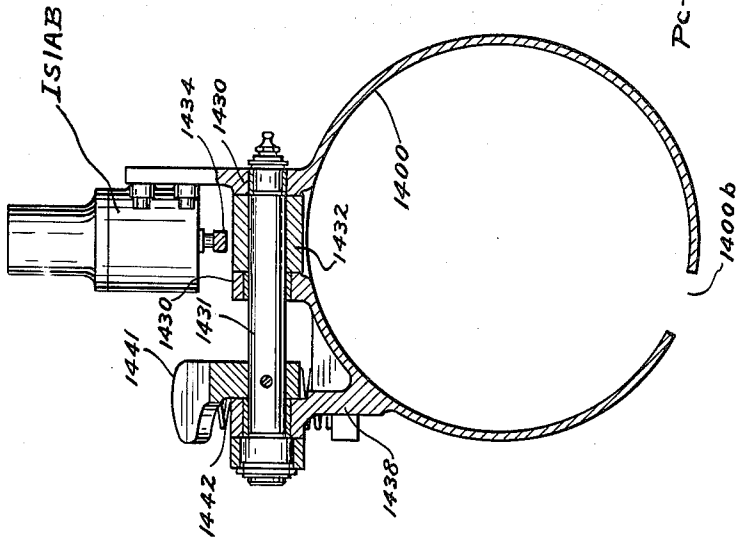


Fig. 96

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 62

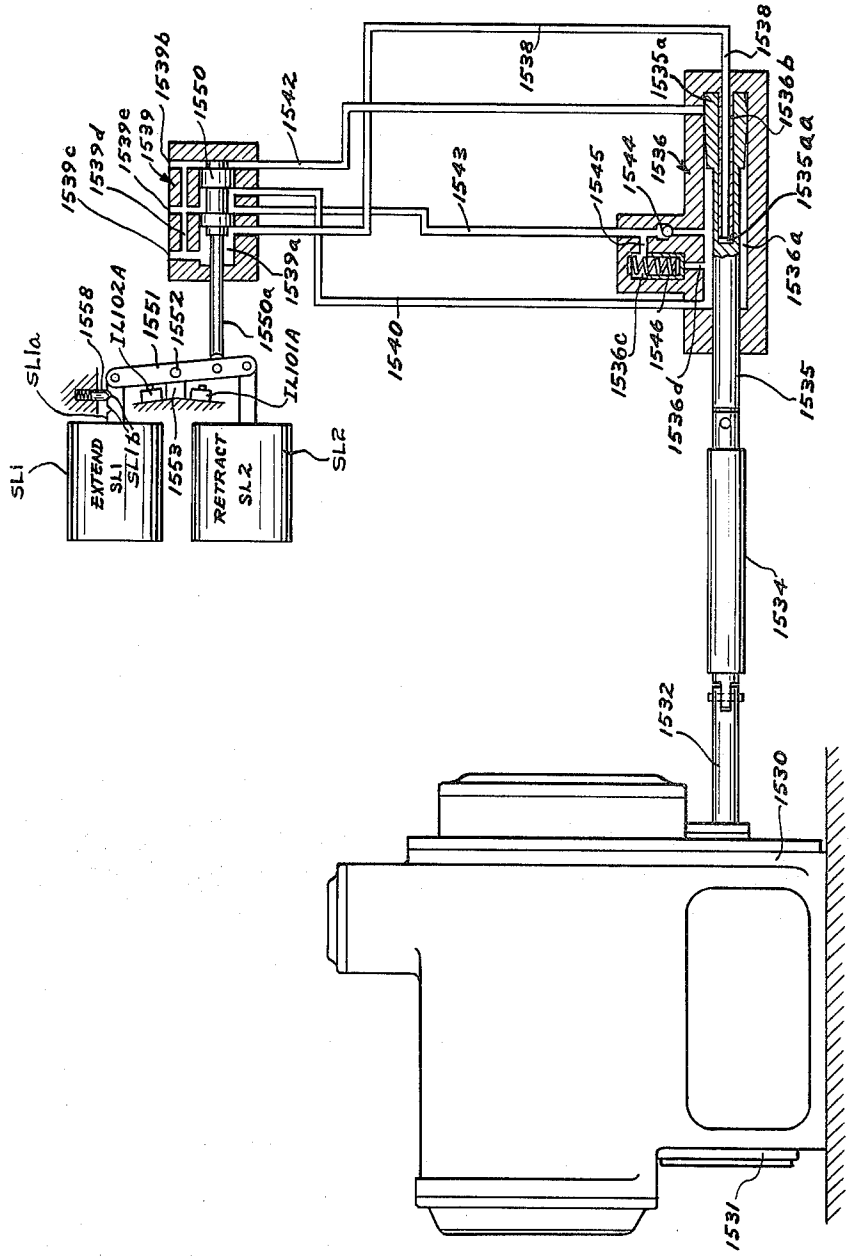
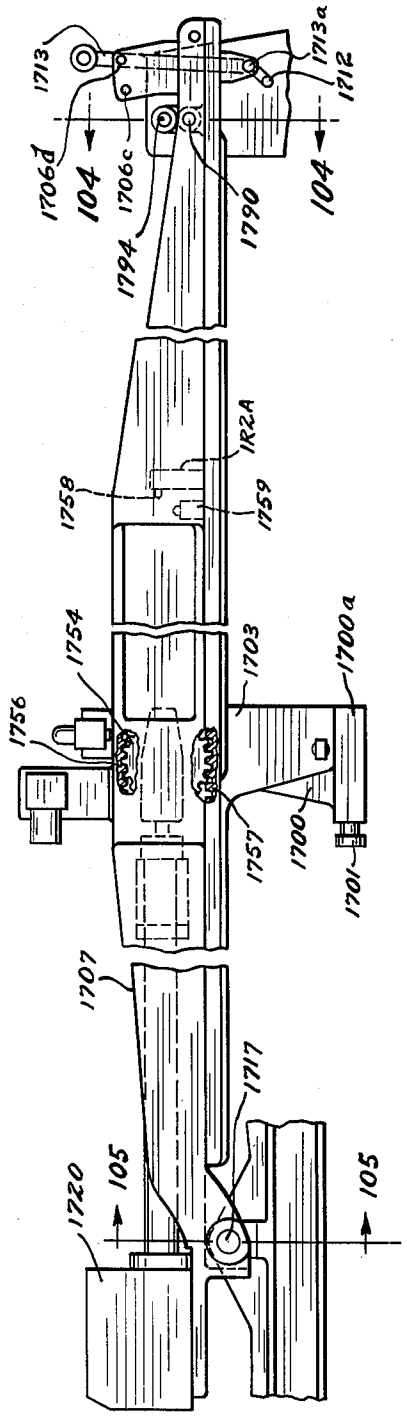


Fig. 97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1713a
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1706d
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1706c
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1790
1794
1R2A
1758
1759
1754
1703
1700a
1756
1757
1700
1701
1707
1717
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105
1720

Fig. 98

Fig. 99

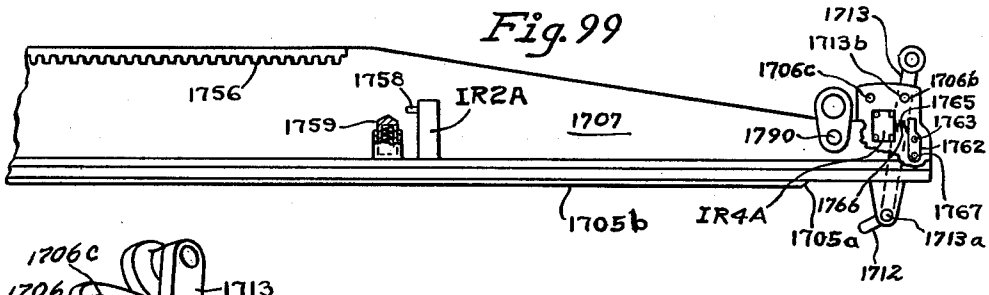


Fig. 100

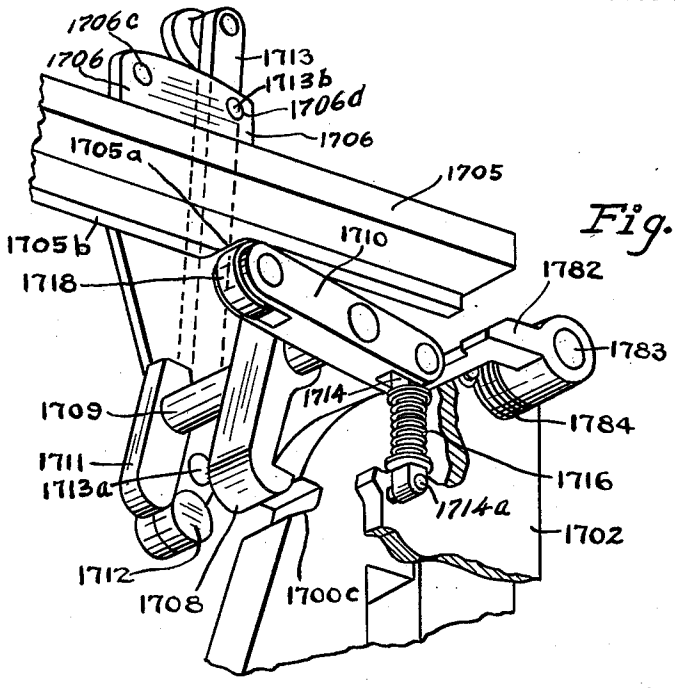


Fig. 101

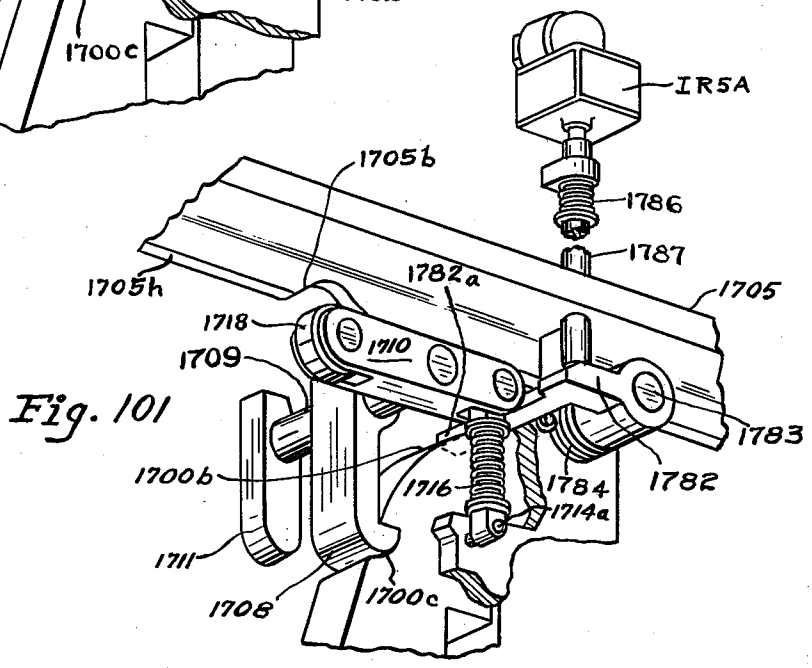


Fig. 102

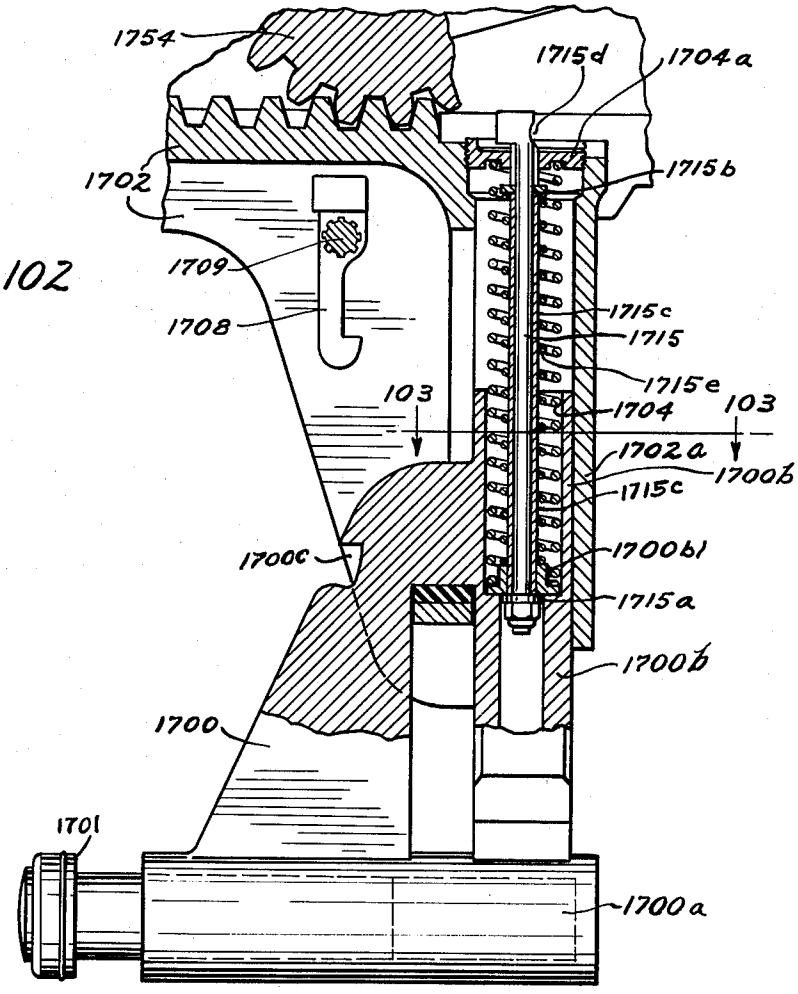
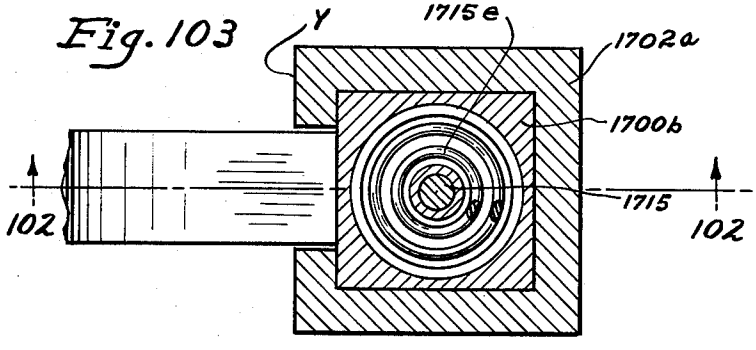


Fig. 103



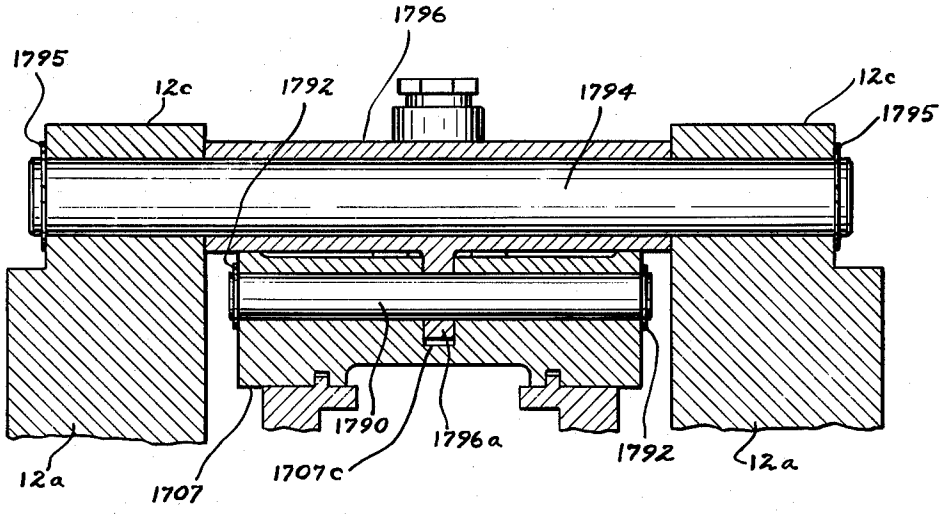


Fig. 104

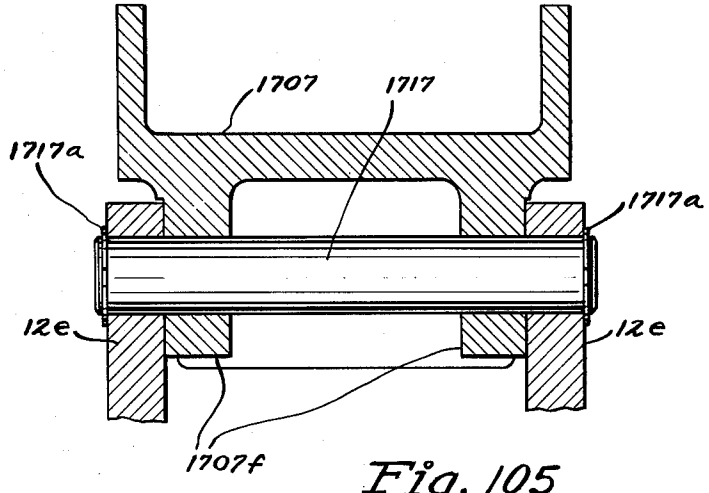
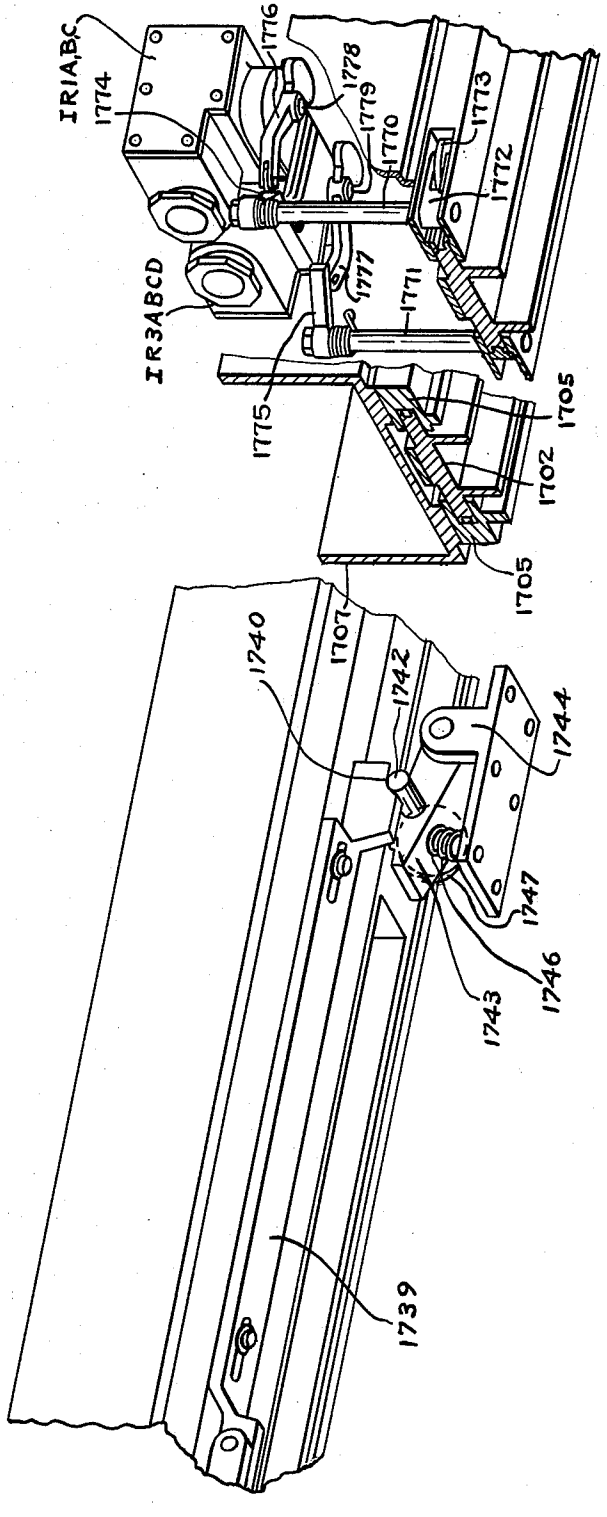


Fig. 105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IR3ABCD
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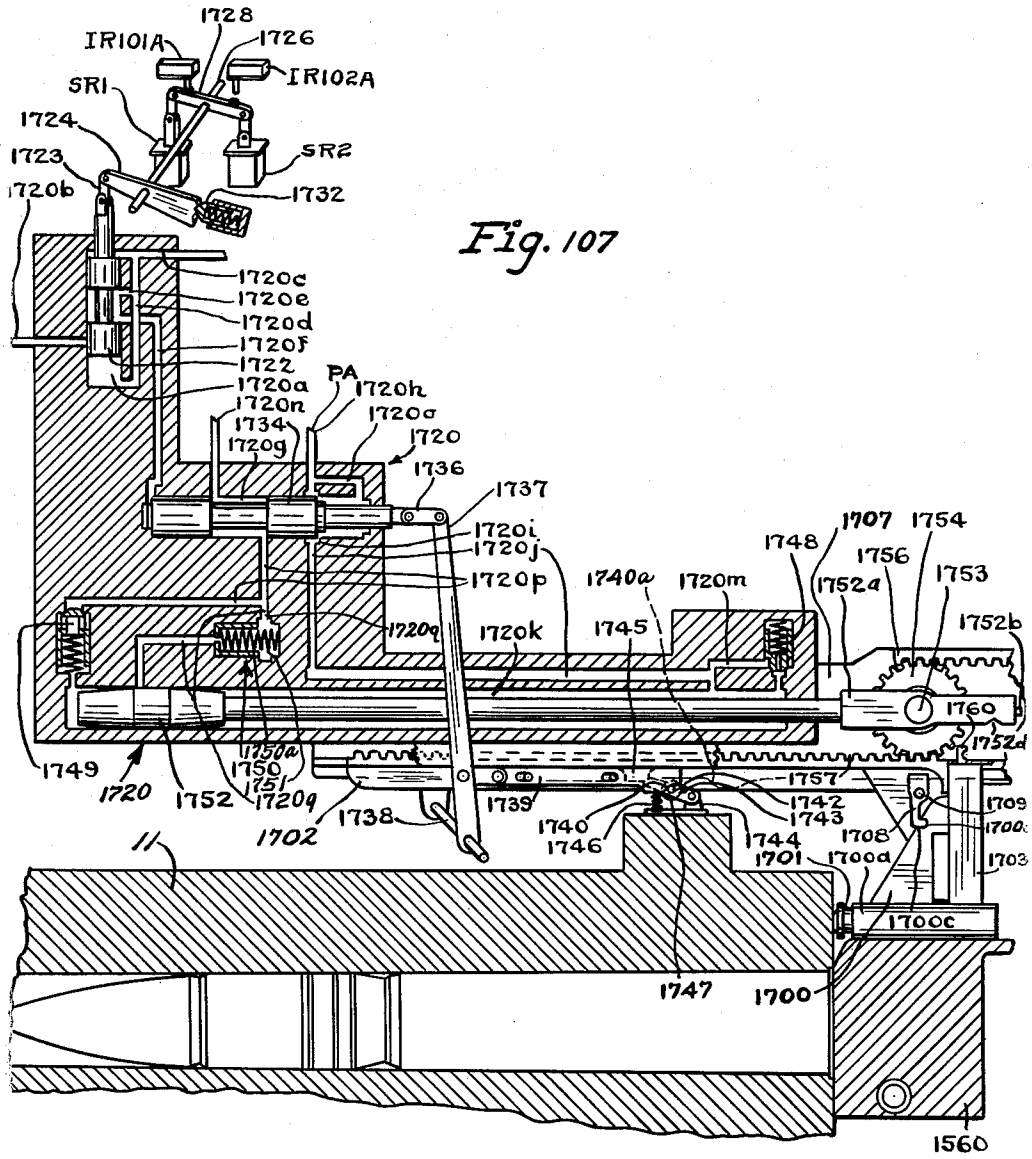
Fig. 106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IR102A
SR1
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1720b
SR2
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1720c
1720e
1720d
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1722
1720a
1720n
1734
1720g
PA
1720h
1720o
1720
1736
1737
1720i
1720j
1720p
1720q
1720k
1740a
1720m
1745
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1707
1754
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1752a
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1752b
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1752d
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1700a
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Fig. 107

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 69

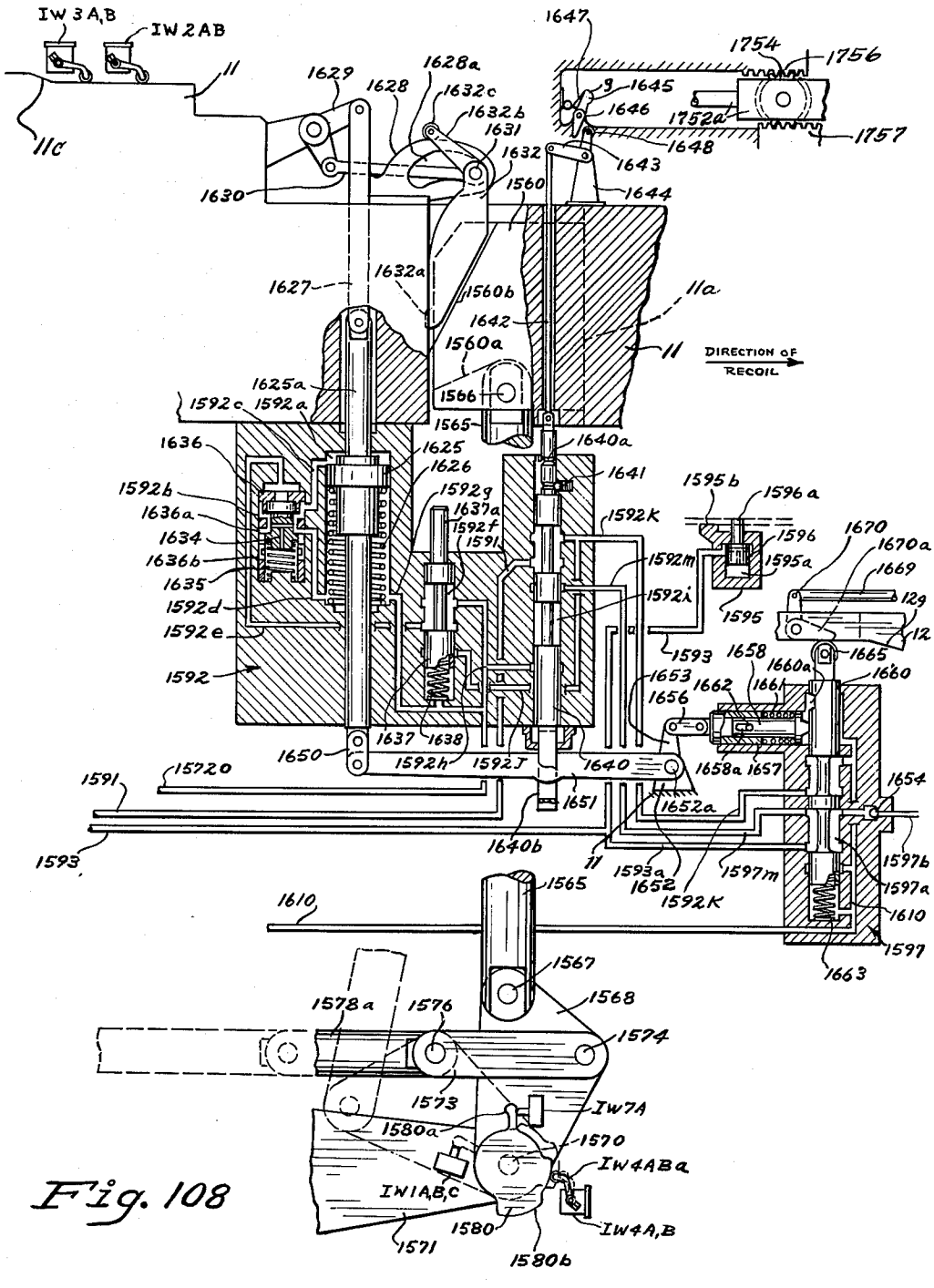
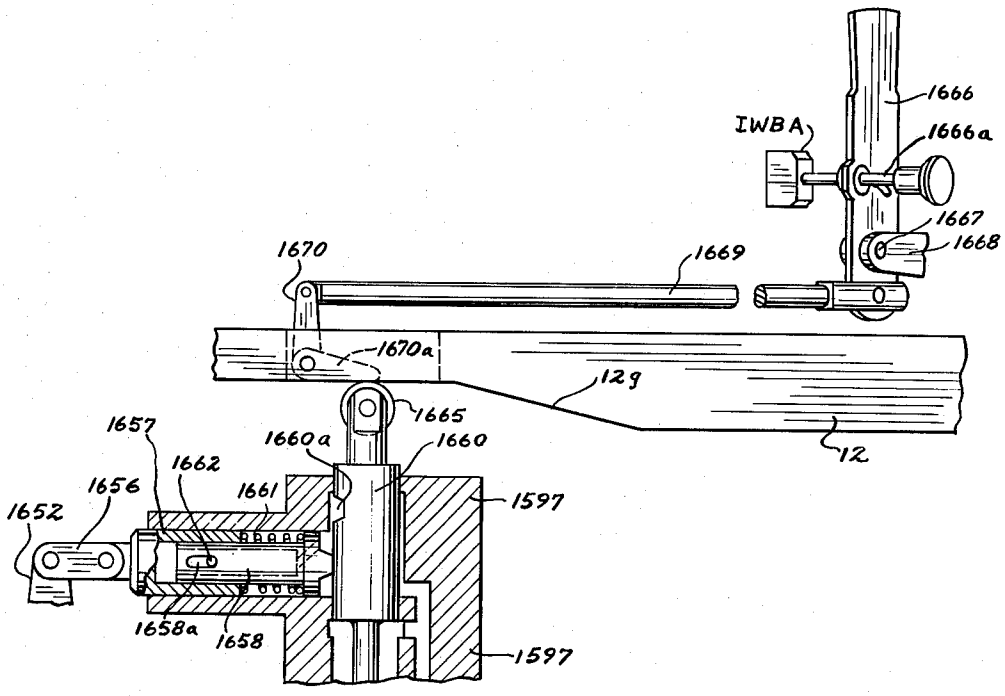


Fig. 108


1666
IWBA
1666a
1667
1668
1670
1669
1670a
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12
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1660a
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Fig. 109

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 71

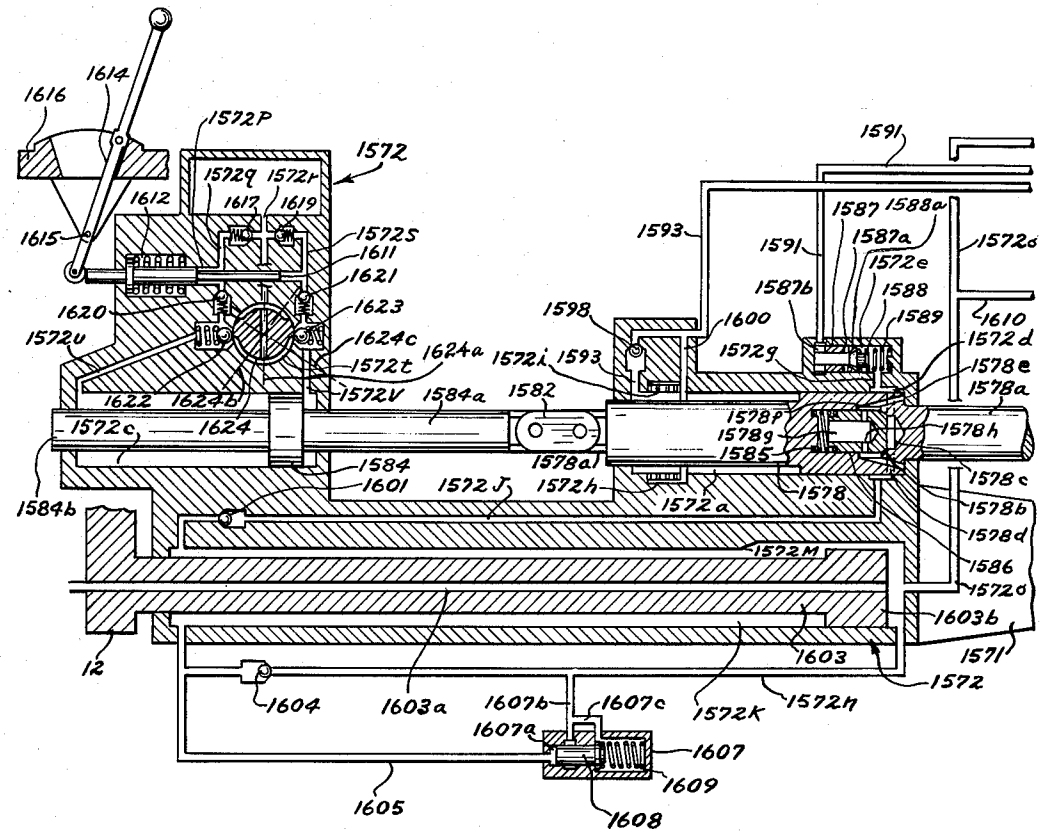

Fig. 110

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 72

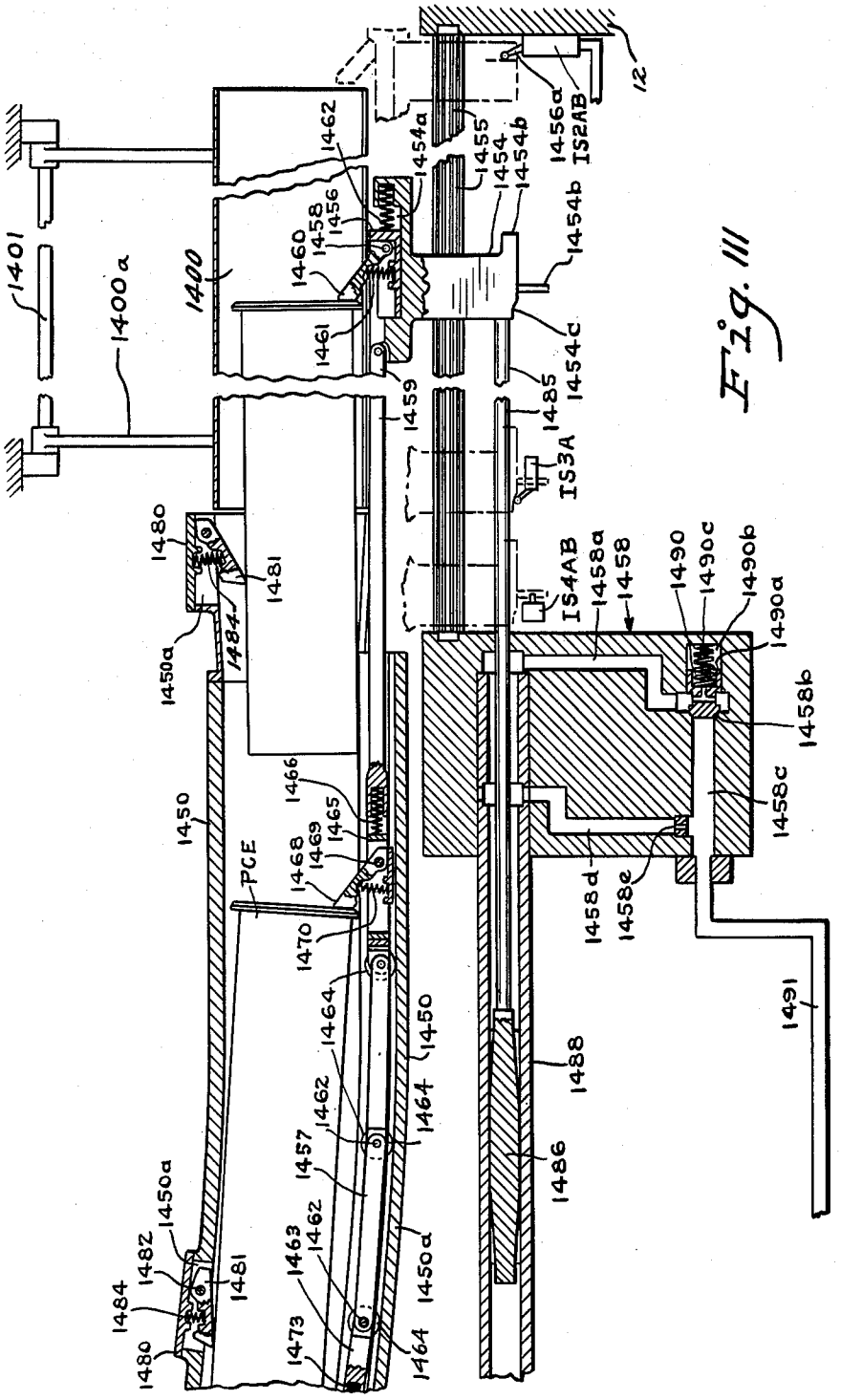

Fig. 111

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 73

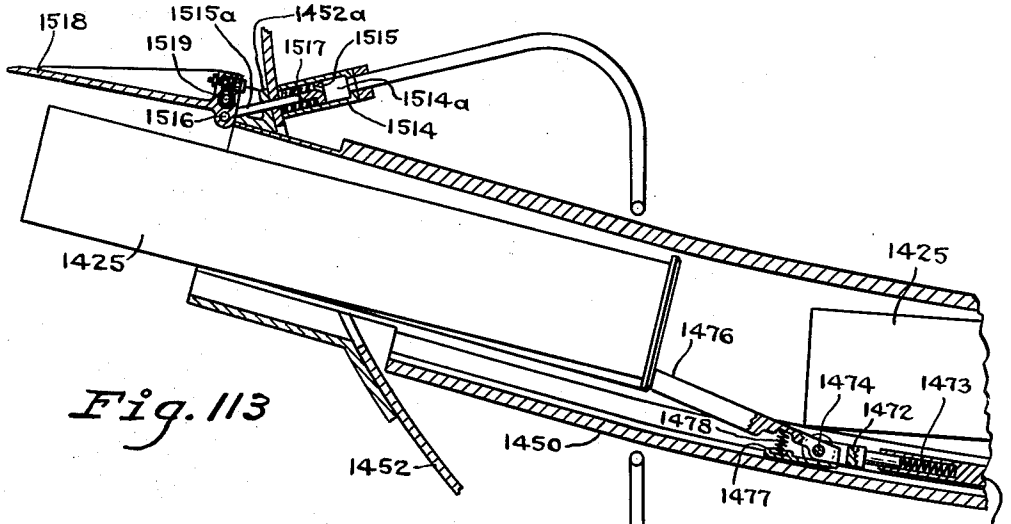

Fig. 113

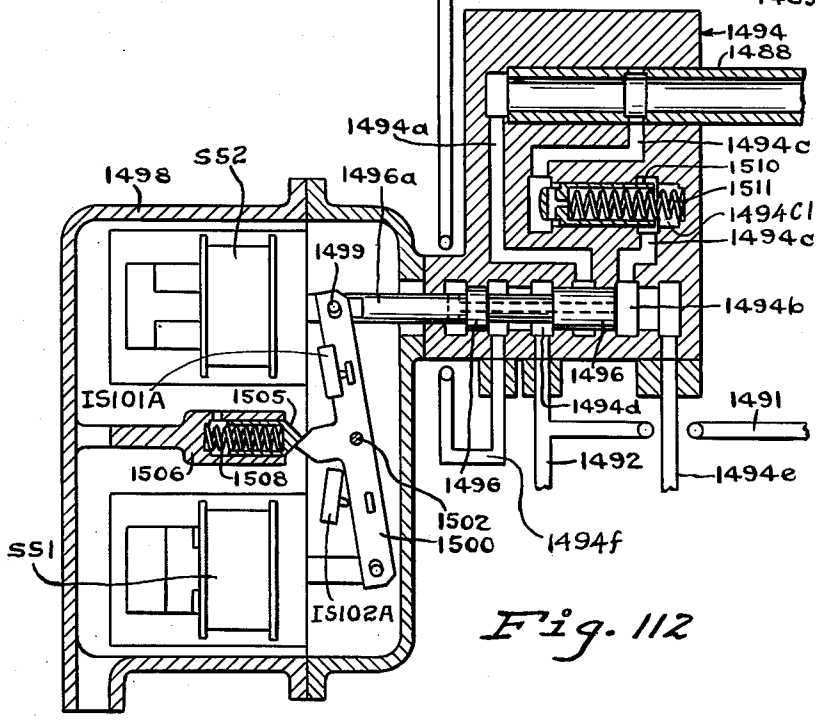

Fig. 112

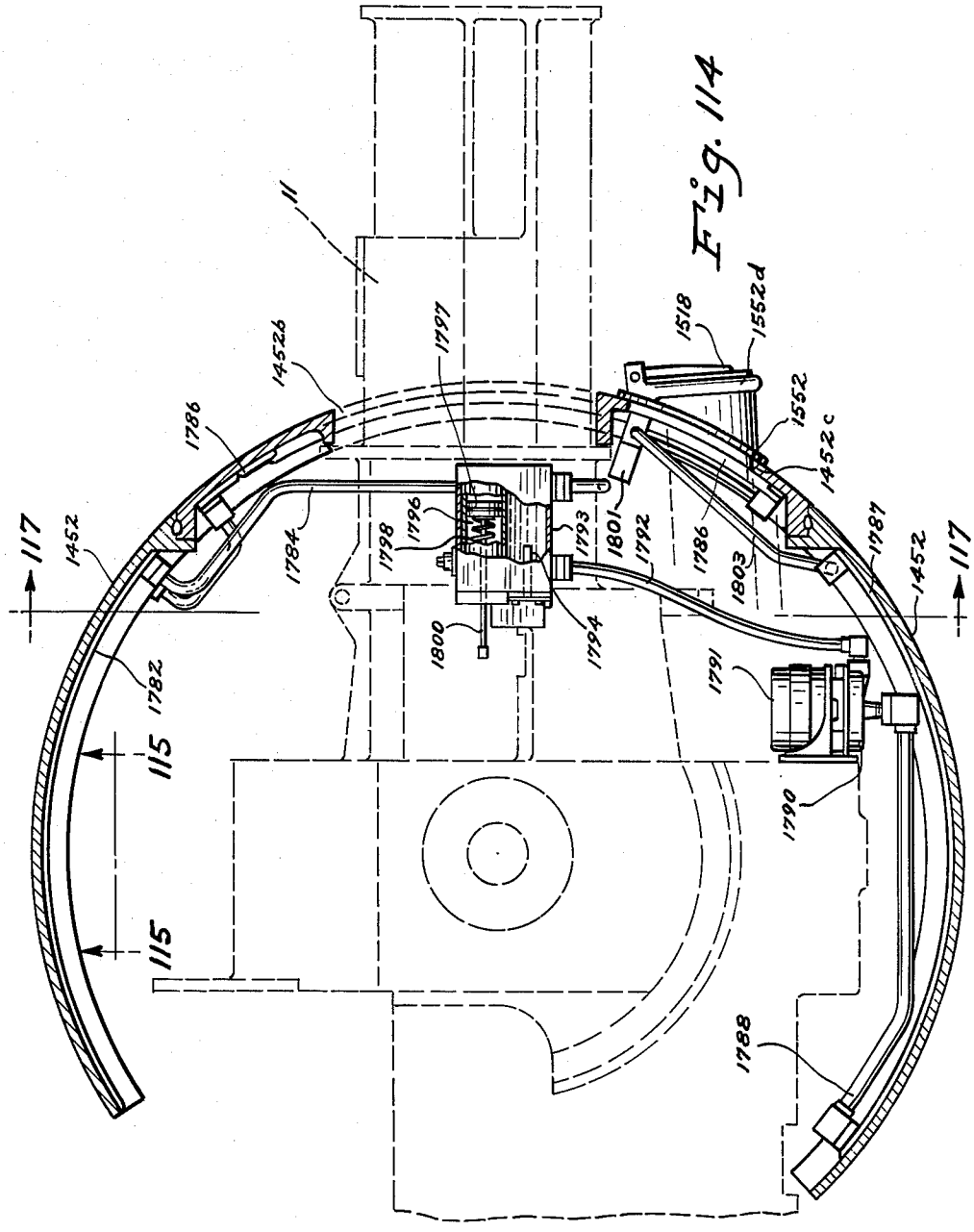
Fig. 114
11
14526
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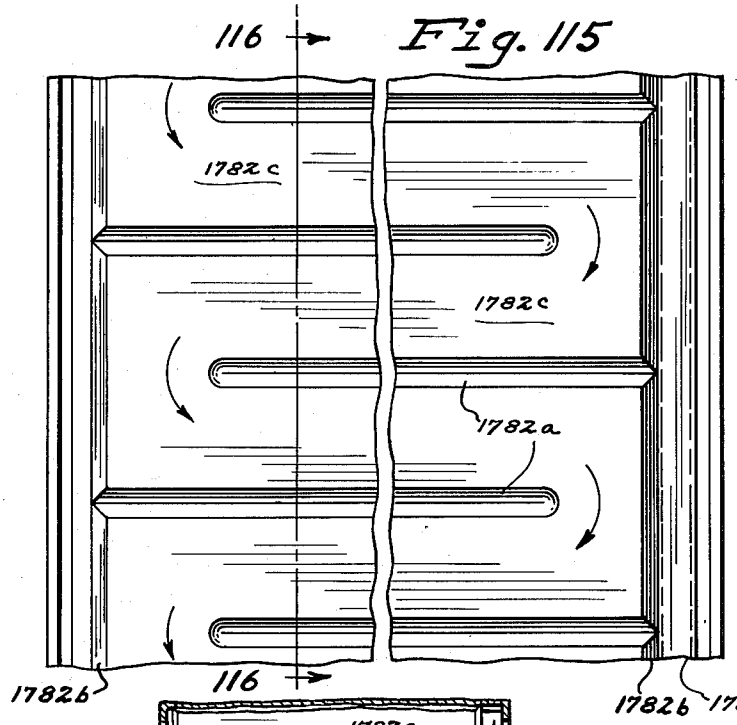
Nov. 23, 1965 P. H. GIROUARD ET AL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 75

Fig. 115



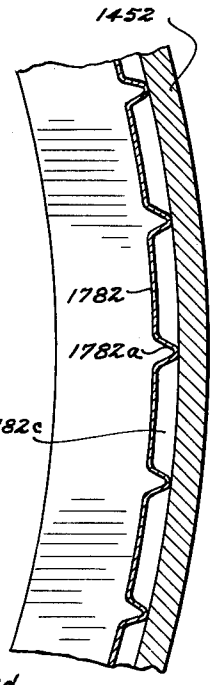


Fig. 116

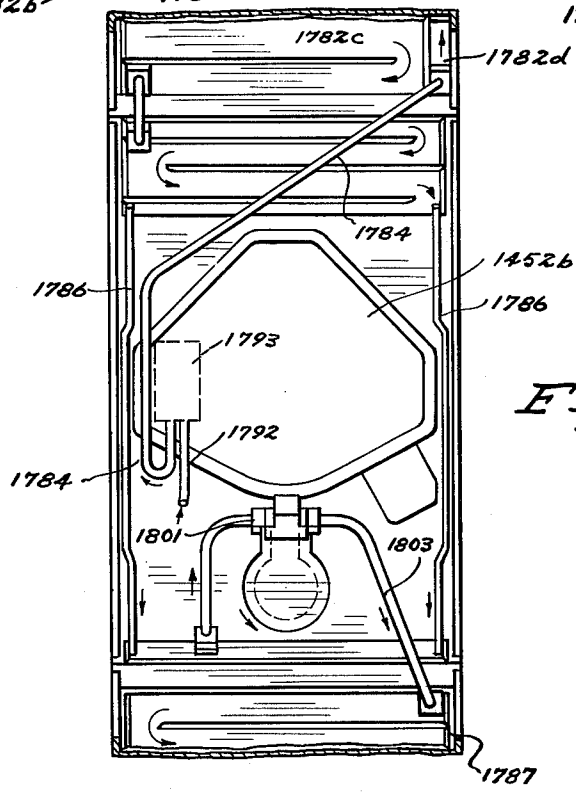


Fig. 117

Nov. 23, 1965 P. H. GIROUARD ETAL 3,218,930

GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Filed Aug. 27, 1952 76 Sheets-Sheet 76

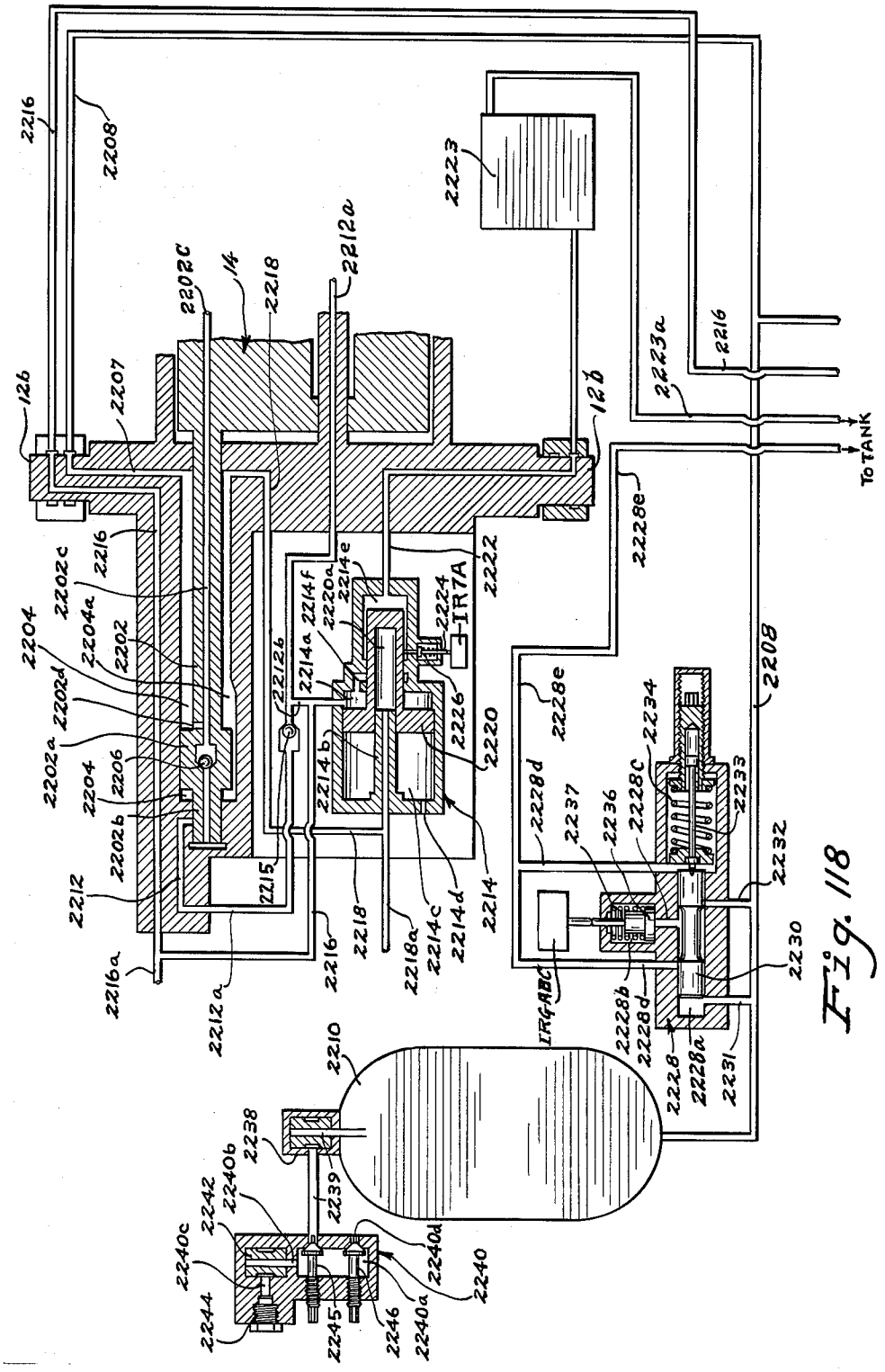


Fig. 118

United States Patent Office 3,218,930 Patented Nov. 23, 1965

3,218,930
GUN MOUNT WITH AMMUNITION SUPPLYING MEANS

Philias H. Girouard, Washington, D.C., Carl V. Hickman, deceased, late of Kensington, Md., by Jean W. Hickman, administratrix, Washington, D.C., Garold A. Kane, John I. Nelson, Milton C. Neuman, and Harrison Randolph, Minneapolis, Minn., and Thomas C. Collier, Washington, D.C., assignors, by direct and mesne assignments, to the United States of America as represented by the Secretary of the Navy

Filed Aug. 27, 1952, Ser. No. 306,612
74 Claims. (Cl. 89—45)

The present invention relates to major caliber guns with calibers of the order of magnitude of five inches or greater preferably employing separate or semi-fixed ammunition and intended to be effective for both anti-aircraft and surface fire and particularly to the mount structure for such guns and the ammunition handling features thereof.

In guns of this caliber it is highly desirable that a substantially normal or conventional position of the gun trunnions be maintained in order to keep the weight of the gun at a minimum in effecting a proper gun balance. In the present invention the gun can be loaded in any position of elevation and of course in any position of turning or training. This makes the invention of high utility in anti-aircraft use.

The instrumentalities for so loading the gun are practically all automatic in their operation and when so operated, are for the most part hydraulically actuated, suitable interlocks being provided to insure the proper sequence of operation and to prevent improper firing of the gun. While the gun of the present invention is to be understood as having a conventional turret mounting, in that it is intended primarily for naval use, this is not necessarily essential. Other well known types of gun mountings may be employed within the purview of the present invention to make the gun available for general military use, whether naval or otherwise. While in the embodiment of the invention illustrated only one gun is shown, it is obvious that the inventive concepts and much of the structure described would be equally applicable to a mount carrying more than one gun.

The mount in general has means for supplying ammunition to the gun including a lower hoist installed on the fixed structure of the ship or other foundation. Said hoist comprises one or more hoist tubes. In the embodiment of the invention illustrated, said hoist comprises a pair of spaced tubes. The units or rounds of ammunition are automatically fed to said tubes respectively by magazines. There is a magazine for each tube and the units or rounds of ammunition are manually fed to said magazines. (It may be noted that this is the only manual operation involved in the operation of the mount while in automatic operation, and further that the manual feed can be continued in order to replenish the ammunition in the various mount parts receiving the same at all times during automatic operation.)

The said magazines are identical and while their structure may be varied to suit the particular ammunition used, in the embodiment of the invention illustrated each magazine comprises a casing in which are disposed two superposed rotatable drums arranged in axial alignment. Each drum has a series of circumferentially spaced chambers. These chambers in the upper drum receive the projectiles and said chambers in the lower drum received the powder cases. The casing has an opening for each drum provided which one or more swinging doors and the powder cases and projectiles are pushed against and past said doors through said openings into said chambers in the

respective drums. Said drums are automatically rotated or indexed and means are provided for preventing indexing while ammunition is being fed into said drums and for locking said doors to prevent feeding of ammunition while said drums are being indexed. This protects the operators. The drums move the projectiles and powder cases into alignment with and into said hoist tubes or passages. The lower hoist has chains moving through said tubes to elevate the ammunition in said tubes to a rotatable carrier. A support is provided for the projectile when moved into said tube and this support is moved from beneath the projectile allowing the latter to rest on top of the powder case and the round is thus moved up in tandem with the projectile riding directly on the powder case plug. The chains in the lower hoist tubes are equipped with retaining members which prevent shucking of the ammunition units during deceleration of the hoist.

The carrier to which the round of ammunition is delivered by said lower hoist is rotatably mounted on a central column which depends from the gun supporting portion or mount proper. The said carrier has circumferentially spaced chambers which receive the ammunition from the tubes of said lower hoist. In the embodiment of the invention illustrated, said chambers in the carrier are spaced 180 degrees apart. The carrier is automatically rotated to bring the chambers thereof into alignment with one or more tubes or passages of an upper hoist, which upper hoist is carried by and rotates with the gun or the mount proper. In the embodiment of the invention illustrated, the upper hoist has two tubes spaced 180 degrees apart. The carrier has a control mechanism which receives information as to the position of the mount proper, and the velocity and direction of rotation of the mount proper. This information is added mechanically and the carrier drive and control mechanism therefor is triggered to cause rotation of the carrier in a direction which will bring its said chambers into alignment with the said tubes of the upper or lower hoists in the shortest period of time. The carrier is provided with latches which are operated to latch it to the upper and lower hoists respectively. Either chamber of said carrier can deliver to either tube of the upper hoist.

The ammunition is automatically transferred laterally from the chambers in the carrier to the tubes of the upper hoist while the carrier is latched to the upper hoist. Upon completion of the transfer the carrier automatically returns to the lower hoist and is latched thereto in position to receive further ammunition from the lower hoist.

The upper hoist, which is illustrated as a shuttle hoist, elevates the units or rounds of ammunition to a cradle. In the embodiment of the invention illustrated, two cradles are provided, one at each side of the gun. Said cradles are respectively carried on arms which respectively swing about the axis of the gun trunnions. The cradle comprises a casing having a chamber therein which receives the unit or round of ammunition from the upper poist while said chamber is in a substantially vertical position, vertically aligned with an upper hoist tube and latched to the upper hoist. The cradle is then automatically swung upward to bring the casing and chamber thereof into position at the rear of the gun and substantially parallel to the gun axis and alongside a transfer tray. The round of ammunition is then automatically transferred laterally or sidewise from the cradle to said transfer tray.

In the embodiment of the invention illustrated two transfer trays are provided, one at each side of the gun adjacent the rear thereof. The round is clamped in position in the transfer tray and while the transfer tray is in its receiving position, the mechanical time fuse is set. The fuse pot of the fuse setter mechanism is automatical-

ly moved to engage and set the said time fuse and the fuse pot is then retracted.

Each tray is moved from a receiving position in which it is substantially parallel to the gun axis and at one side and adjacent the rear of the gun, in which position it receives the round from the cradle, to a discharging or ramming position in axial alignment with the gun bore. The round is then rammed from the tray into the breech by the rammer. The transfer trays are alternately moved to a ramming position so that one tray is being loaded while the other is having the round rammed therefrom. As soon as the rammer cross-head has cleared the forward end of the transfer tray the transfer tray starts back to receiving position.

The breech block is raised to closing position immediately after the rammer is retracted.

As soon as the charge is fired the breech block is lowered. The operation of the breech block both in closing and opening is automatically and hydraulically powered. Triggering of the opening cycle of the block is accomplished by valving which is actuated during recoil.

An empty case tray is provided which moves from a receiving position in which it is in substantial alignment with the gun bore to a discharge position below the gun bore. The empty case tray moves to its receiving position between each movement of a transfer tray to ramming position. Suitable interlocks are provided to prevent any interference of the transfer trays and the empty case tray.

A discharge chute for the empty cases is provided into which the empty cases are discharged by the empty case tray. The empty cases are then moved through said chute and are discharged at the end thereof.

In the light of the foregoing, it is an object of this invention to provide a mount for a gun comprising means for supplying ammunition to said gun including a series of cooperating mechanisms which move the round from the magazine deck to the gun.

It is another object of this invention to provide a mount for a gun comprising a series of cooperating and successively operating mechanisms for moving the round from adjacent an off-mount storage space to and into the gun, and while such mechanisms could be operated and controlled pneumatically or mechanically, in the embodiment of the invention illustrated, said means and mechanisms are hydraulically and electrically operated and controlled.

It is a further object of this invention to provide a mount for a gun by which the round is moved from a magazine, in which the rounds are manually placed, by a series of cooperating and successively automatically operating mechanisms to and into the gun.

It is also an object of this invention to provide a mount for a gun comprising means for supplying ammunition to said gun from an off-mount storage space to said gun through a series of cooperating mechanisms including a lower hoist adapted to receive a round of ammunition, and transfer the same to a rotatable carrier, an upper hoist adapted to receive said round from said carrier and transfer the same to a swinging cradle which in turn delivers said round to a transfer tray by which the round is moved into axial alignment with the breech end of the gun bore to be rammed therein, said tray moving with said gun in its training and elevating movement whereby said round can be supplied to said gun in any position of said gun and while said gun is in motion both in train and in elevation.

It is also an object of this invention to provide a mount for a gun having training and elevating movements comprising a transfer tray movable with said gun in said training and elevating movements and adapted to receive a round of ammunition, said tray having its longitudinal axis substantially parallel with the axis of the gun barrel and movable relatively to said gun from a round-receiving position to a discharging position with the round of ammunition therein in axial alignment with the gun barrel.

It is a further object of this invention to provide such a structure as set forth in the preceding paragraph in which there is one of said transfer trays as set forth at each side of the gun, together with means for alternately moving said trays to round-receiving and discharging positions.

Another object of the invention is to provide such a structure as set forth in the preceding paragraph save one, together with a cradle which receives the round of ammunition which is swingable from a round-receiving position to a discharging position alongside said transfer tray, together with means for transferring a round of ammunition from said cradle to said transfer tray while said cradle is in said discharging position.

It is also an object of this invention to provide such a gun mount as set forth in the preceding paragraph in which said cradle is carried on an arm swingable about the axis of a gun trunnion so as to swing from a substantially vertical round-receiving position to a position alongside of said transfer tray.

Another object of this invention is to provide a mount for a gun comprising means for moving the round from a loader to a rotatable carrier which in turn delivers the round to an upper hoist which delivers the round to a swinging cradle by which the round is moved and delivered to a transfer tray, which tray moves the round into axial alignment with the bore of the gun into which it is rammed.

It is still another object of this invention to provide a gun mount comprising a transfer tray at each side of the gun as above set forth, together with a cradle for each of said trays, which cradles are respectively carried on arms swingable about the axes of the gun trunnions respectively from round-receiving positions to discharge positions respectively aligned with said transfer trays.

It is is another object of this invention to provide a gun mount having one or two cradles as above set forth, swingable from a substantially vertical round-receiving position to a position adjacent a transfer tray, together with an upper hoist adapted to receive one or more rounds of ammunition and transfer the same to said cradle or cradles respectively.

It is also an object of the invention to provide a mount for a gun comprising an empty case tray, means for ejecting an empty case from the breech of said gun into said tray, said tray being movable from a discharging position below the gun bore to a receiving position substantially in coaxial alignment with said bore.

It is still another object of the invention to provide a mount for a gun having means for supplying ammunition for said gun including transfer trays at either side of said gun adjacent the rear thereof, an empty case tray movable from a position below the bore of said gun at the breech thereof to a position in axial alignment with said bore, together with means for alternately moving said transfer trays to a discharge position in axial alignment with said bore, and means for moving said empty case tray into axial alignment with said bore between each movement of a transfer tray into such alignment.

It is a further object of the invention to provide an empty case ejector chute with means for moving empty cases from the empty case tray into said chute while said tray is in its discharging position, and to progress the same along said chute and past a door at the discharge end thereof, said chute adjacent its discharge end preferably extending through the gun shield.

It is also an object of this invention to provide a mount for a gun comprising means for supplying ammunition to said gun including a transfer tray which is movable to a receiving position at one side of the gun where it receives a projectile and is then movable to a position to bring said projectile into axial alignment with the gun bore, together with a fuse-setting mechanism, and means for moving said fuse-setting mechanism into engagement with said projectile to set the fuse while said projectile is in said

transfer tray, and preferably when said tray is in receiving position.

It is a further object of this invention to provide a mount for a gun comprising means for transferring a round of ammunition from a manually operated magazine to and into the gun by successive mechanisms including a lower hoist, a rotatable carrier into which the round is moved by said lower hoist, which carrier moves the round to an upper hoist which rotates with the gun in its training movement.

It is still another object of this invention to provide a mount for a gun having training and elevating movements comprising an upper hoist rotatable with the gun in its training movement and having a hoist tube for receiving a round of ammunition together with means for rotating said carrier from a round-receiving position to a position with said chamber in alinement with said hoist tube so that said round can be transferred to said tube.

It is a further object of the invention to provide such a structure as set forth in the preceding paragraph, together with means for selectively determining the direction of rotation of said carrier so as to bring said chamber into alinement with said hoist tube in the shortest period of time.

It is also an object of this invention to provide a mount for a gun comprising an upper hoist rotatable with the gun in its training movement and having one or more hoist tubes, each hoist tube being adapted to receive a round of ammunition, together with a rotatable carrier axially alined with said hoist and having round-receiving means adapted to be brought into alinement with said hoist tube or tubes respectively.

It is also an object of this invention to provide such a structure as set forth in the preceding paragraph, together with means for selectively determining the direction of rotation of said carrier to bring said means into alinement with said hoist tube or tubes respectively in the shortest period of time.

It is another object of the invention to provide a mount for a gun comprising means for supplying ammunition to said gun including an upper hoist rotatable with the gun in its training movement and having hoist tubes disposed 180 degrees apart, each adapted to receive a round of ammunition, together with a rotatable carrier coaxial with said hoist and having chambers disposed 180 degrees apart, each adapted to receive a round of ammunition, together with means for rotating said carrier to bring said chambers into lateral alinement with said hoist tubes.

It is a further object of the invention to provide a gun mount comprising a rotatable carrier having one or more chambers for receiving rounds of ammunition and delivering the same to an upper hoist, together with a lower hoist having one or more hoist tubes with which said chambers of said carrier are adapted to aline respectively, together with means for operating said lower hoist to transfer rounds of ammunition from said lower hoist tubes to said chambers of said carrier respectively.

It is another object of this invention to provide a mount for a gun comprising means for supplying ammunition to said gun including a lower hoist adapted to receive a unit of ammunition, together with a magazine device for supplying said unit to said hoist.

It is another object of this invention to provide a mount for a gun comprising means for supplying ammunition to said gun including a lower hoist adapted to receive a round of ammunition comprising a powder case and a projectile, together with a magazine device having means for supplying a powder case to said hoist, and means for supplying a projectile to said hoist.

It is also an object of this invention to provide a gun mount comprising a lower hoist having spaced tubes for respectively receiving rounds of ammunition, together with a magazine device for delivering units of ammunition to said tubes respectively.

It is a further object of the invention to provide a gun mount comprising a lower hoist and magazine device as set forth in the preceding paragraph, which magazine device comprises a plurality of magazines, one for each tube of said lower hoist, each of said magazines comprising a powder drum and a projectile drum into which powder cases and projectiles are respectively fed by operators.

It is also an object of this invention to provide a structure of mount as set forth in the preceding paragraph in which each of said magazines has its projectile drum above and axially alined with its powder drum, said drums being respectively rotatable to bring the projectiles and powder cases therein into alinement with a lower hoist tube and a swinging door for each of said drums past which the projectiles and powder cases are respectively pushed by the operators.

It is further an object of this invention to provide a mount for a gun comprising means for supplying ammunition to said gun including a lower hoist, a magazine device for said hoist comprising a rotatable powder drum and a rotatable projectile drum, a swinging door for each of said drums past which powder cases and projectiles are respectively moved into said drums, said doors being moved by said powder cases and projectiles respectively, and means operated by said doors respectively when so moved for locking the drum thereof in stationary position.

It is still another object of this invention to provide such a structure as set forth in the preceding paragraph, together with a latch-releasing member for each of said drums which must be released by the operator before its respective drum can be rotated.

It is also an object of this invention to provide such a structure as set forth in the preceding paragraph save one, in which a pair of swinging doors are provided for each of said drums, said doors being inclined inwardly and being swung by the powder cases and projectiles respectively when pushed therebetweeen.

It is another object of this invention to provide a mount for a gun having parts powered from an accumulator system, a recoil mechanism for said gun together with means actuated by the recoil of said gun for charging fluid into the accumulator system.

It is a further object of this invention to provide a mount for a gun, in which a shield is provided for said gun through which said gun projects, together with a novel and efficient means for maintaining said shield at a desired temperature.

It is still another object of this invention to provide a mount for a gun, including a rammer for ramming a round of ammunition into said gun, together with novel means for operating said rammer.

It is also an object of this invention to provide a mount for a gun, including a breech block movable to operative or closed position and to inoperative or open position, together with a novel and efficient power operated mechanism for moving said block to said positions.

It is still another object of this invention to provide a mount for a gun, including a breech block movable to operative or closed position and to inoperative or open position, together with novel and efficient manually operated mechanism for moving said block to said positions.

It is still further an object of this invention to provide such a structure as set forth in the two preceding paragraphs, together with means operated with the movement of said breech block for ejecting the empty case shell from said gun.

These and other objects and advantages of the invention will be fully set forth in the following description made in connection with the accompanying drawings in which like reference characters refer to similar parts throughout the several views and in which:

FIG. 1 is a somewhat schematic perspective view of the mount, some parts being broken away;

FIG. 1*a* is a schematic perspective view of the upper portion of the mount, some parts being broken away;

FIG. 1*b* is a vertical section taken substantially on line **1***b*—**1***b* of FIG. 1*a* looking forwardly as indicated by the arrows;

FIG. 2 is a view in front elevation of the principal portions of the mount;

FIG. 3 is a view in front elevation of the magazine device also showing portions of the lower hoist casing;

FIG. 4 is a vertical central section through one of the magazine casings showing the powder case drum and the projectile drum;

FIG. 5 is a partial sectional view similar to FIG. 4;

FIG. 6 is a partial sectional view similar to FIG. 4;

FIG. 7 is a view in side elevation of a magazine casing and parts carried thereby, some parts being broken away;

FIG. 8 is a perspective view of a door locking means forming part of the magazine;

FIG. 9 is a schematic view in vertical section showing part of the magazine and the hydraulic means for operating the same;

FIG. 10 is a horizontal section taken substantially on line **10**—**10** of FIG. 7, as indicated by the arrows;

FIG. 11 is a horizontal section of the door locking device for the magazine; some parts being shown in dotted lines;

FIG. 12 is a horizontal section taken substantially on line **12**—**12** of FIG. 7, as indicated by the arrows;

FIG. 13 is a horizontal section taken substantially on line **13**—**13** of FIG. 7, as indicated by the arrows;

FIG. 14 is a partial top plan view of the magazine;

FIG. 15 is a perspective view of the mechanism for depositing the projectile onto the powder case;

FIG. 15*a* is a horizontal section taken substantially on line **15***a*—**15***a* of FIG. 15*b*;

FIG. 15*b* is a vertical section taken substantially as indicated by line **15***b*—**15***b* of FIG. 15 showing a portion of the casing enclosing some of the parts;

FIG. 16 is a view in side elevation of the lower hoist and a magazine mechanism, some parts being broken away, said view also showing a supporting ring in vertical section;

FIG. 17 is a horizontal section taken substantially on line **17**—**17** of FIG. 16, as indicated by the arrows;

FIG. 18 is a horizontal section taken on line **18**—**18** of FIG. 16, as indicated by the arrows;

FIG. 19 is a vertical section taken on line **19**—**19** of FIG. 20, as indicated by the arrows;

FIG. 20 is a vertical section taken on line **20**—**20** of FIG. 19, as indicated by the arrow;

FIG. 21 is a view in side elevation of a pawl and portion of the chain of the lower hoist;

FIG. 22 is a vertical section taken on line **22**—**22** of FIG. 21, as indicated by the arrows;

FIG. 23 is a view in side elevation of a portion of the lower hoist chain with a guiding lug thereon;

FIG. 24 is a longitudinal sectional section through a portion of the lower hoist tube showing the hoist chain and parts thereon engaging the powder case and projectile;

FIG. 25 is a mechanical schematic view of the lower hoist operating mechanism;

FIG. 25*a* is a vertical section taken as indicated by line **25***a*—**25***a* of FIG. 25;

FIG. 26 is a schematic view of a portion of the hydraulic operating mechanism for the lower hoist;

FIG. 27 is a schematic view of the other portion of the hydraulic operating mechanism for the lower hoist;

FIG. 27*a* is a vertical section taken on line **27***a*—**27***a* of FIG. 27 as indicated by the arrows;

FIG. 27*b* is a vertical section taken on line **27***b*—**27***b* of FIG. 27 as indicated by the arrows;

FIG. 28 is a diagram of an electrical circuit used in the lower hoist;

FIG. 29 is a view in front elevation of a portion of the mount showing the carrier, upper hoist and a portion of the lower hoist;

FIG. 30 is a view similar to FIG. 29 shown on an en larged scale and showing a portion of the parts shown in FIG. 29;

FIG. 31 is a schematic view of a portion of the carrier and lower hoist shown partly in section on line **31**—**31** of FIG. 32 and partly in side elevation;

FIG. 32 is a top plan view of a portion of the carrier shown on an enlarged scale;

FIG. 33 is a top plan view of the transfer mechanism of the carrier and upper hoist;

FIG. 34 is a view similar to FIG. 33 showing the parts in different positions;

FIG. 35 is a view in side elevation of a portion of the carrier, some parts being broken away and others shown in vertical section;

FIG. 36 is a view in front elevation of a portion of the carrier, some parts being broken away and others shown in vertical section;

FIG. 37 is a schematic view of a portion of the carrier;

FIG. 38 is a schematic view partly in plan and partly in horizontal section of the operating mechanism for the transfer mechanism of the carrier and upper hoist;

FIG. 39 is a view partly in front elevation and partly in vertical section of a portion of the carrier and latch mechanism therefor;

FIG. 40 is a view partly in front elevation and partly in vertical section of a portion of the carrier and the latching mechanisms therefor;

FIG. 41 is a schematic view of the hydraulic operating mechanism for the carrier;

FIG. 41*a* is a diagrammatic plan view of a cam used;

FIG. 42 is a schematic view showing some of the operating mechanism for the carrier;

FIG. 43 is a schematic view of a portion of the operating mechanism for the carrier;

FIG. 43*a* is a diagrammatic horizontal section showing differential gears and a cam used in the carrier control mechanism;

FIG. 44 is a schematic view of a portion of the operating mechanism for the carrier;

FIG. 44*a* is a partial vertical section through the parts for driving the mount proper in the training movement of the gun;

FIG. 45 is a schematic view illustrating the operation of the upper hoist;

FIG. 46 is a view in front elevation of the upper hoist casings and mechanism carried thereby;

FIG. 47 is a perspective view of a clutch mechanism for the upper hoist;

FIG. 48 is a view partly in side elevation and partly in vertical section taken substantially on line **48**—**48** of FIG. 46, as indicated by the arrow;

FIG. 49 is a horizontal section taken substantially on line **49**—**49** of FIG. 46, as indicated by the arrows;

FIG. 50 is a horizontal section taken substantially on line **50**—**50** of FIG. 48, as indicated by the arrows;

FIG. 51 is a schematic view partly in section and partly in side elevation of the operating mechanism for the upper hoist;

FIG. 52 is a schematic view of the cradle mostly in side elevation but partly in vertical section;

FIG. 53 is a schematic view showing the cradle, its carrying arm and guide in side elevation and the journal about which it swings in vertical section;

FIG. 54 is a view partially in perspective and partially in vertical section showing the hydraulic mechanism and associated parts for swinging the cradle;

FIG. 55 is a perspective view of a part of the cradle operating mechanism, a portion thereof being shown in horizontal section;

FIG. 56 is a partial perspective view of the cradle operating mechanism;

FIG. 57 is a view partially in perspective and partly in

vertical section showing the control valves for the cradle and the solenoid mechanism therefor;

FIG. 58 is a schematic view showing control valves for the cradle and the latch for locking the cradle to the upper hoist;

FIG. 59 is a perspective view of a switch operating mechanism in the cradle structure;

FIG. 60 is a perspective schematic view of the cradle and part of the operating mechanism therefor;

FIG. 61 is a schematic view partly in side elevation and partly in vertical section of a portion of the cradle mechanism;

FIG. 62 is a schematic view in perspective of a part of the cradle mechanism;

FIG. 63 is a schematic view in end elevation of a portion of the cradle mechanism, certain parts being shown in dotted lines;

FIG. 64 is a view in vertical section of the cradle operating arm and associated parts;

FIG. 65 is a view in vertical section of the cradle buffer;

FIG. 66 is a schematic view showing the hydraulic and electric control mechanism for the round transfer mechanism of the cradle;

FIG. 67 is a schematic view mostly in vertical section of a hydraulic control and associated mechanism forming part of the cradle;

FIG. 68 is a view partly in side elevation and partly in vertical section showing the cradle, transfer tray and transfer mechanism, some parts being shown in dotted lines;

FIG. 69 is a view partly in side elevation and partly in transverse vertical section of the cradle and associated parts;

FIG. 70 is a view in side elevation of the cradle and cradle guide, some parts being shown in dash lines;

FIG. 71 is a view in end elevation of the cradle guide;

FIG. 72 is a horizontal section taken on line **72—72** of FIG. 70, as indicated by the arrows;

FIG. 73 is a horizontal section taken on line **73—73** of FIG. 72, as indicated by the arrows;

FIG. 74 is a schematic view partly in side elevation and partly in vertical section showing the latch for latching the cradle to the slide and its control mechanism, said figure relating to the left-hand cradle;

FIG. 75 is a vew similar to FIG. 74 and relating to the right-hand cradle;

FIG. 76 is a view in side elevation of a transfer tray;

FIG. 77 is a schematic view in vertical section showing the transfer tray, the round clamping means and certain control means;

FIG. 78 is a schematic view in end elevation of a transfer tray and certain operating mechanism therefor;

FIG. 79 is a schematic view in end elevation of the transfer tray and certain associated parts;

FIG. 80 is a view partly in end elevation and partly in vertical section showing a transfer tray and certain associated mechanism;

FIG. 81 is a schematic view partly in end elevation and partly in vertical section of a transfer tray, some associated mechanism and the hydraulic controls therefor;

FIG. 82 is a view similar to FIG. 80 showing the transfer tray which is located at the opposite side of the gun;

FIG. 83 is a view similar to FIG. 79 showing the transfer tray which is located at the opposite side of the gun;

FIG. 84 is a view similar to FIG. 78 showing the tranfer tray which is located at the opposite side of the gun;

FIG. 85 is a partial schematic view partly in end elevation and partly in transverse vertical section showing the shutter for the transfer tray and its operating members;

FIG. 86 is a schematic view partly in end elevation and partly in vertical section of one transfer tray, its supporting arm and hydraulic and other operating mechanism;

FIG. 87 is a view similar to FIG. 86 but showing the transfer tray which is located at the opposite side of the gun;

FIG. 88 is a view in side elevation of a valve block for the empty case tray and certain parts carried thereby;

FIG. 89 is a view of the empty case tray, its support and operating mechanism therefor;

FIG. 90 is a schematic view of the hydraulic mechanism for operating the transfer trays and empty case tray;

FIG. 91 is a partial view similar to FIG. 87 showing some parts in different positions;

FIG. 92 is a view in side elevation of the empty case tray and parts carried thereby;

FIG. 93 is a view in end elevation of the empty case tray;

FIG. 94 is a sectional view taken on line **94—94** of FIG. 93;

FIG. 95 is a view in vertical section of one end portion of the empty case tray;

FIG. 96 is a view in vertical section taken on line **96—96** of FIG. 95, as indicated by the arrows;

FIG. 97 is a schematic view partly in side elevation and partly in vertical section showing the fuse setting mechanism;

FIG. 98 is a schematic view in side elevation of the rammer and associated parts;

FIG. 99 is a schematic view in side elevation of the rear portion of the rammer;

FIG. 100 is a perspective view of the latching mechanism for the rammer spade;

FIG. 101 is a perspective view of the latch for the rammer spade and associated parts;

FIG. 102 is a vertical section taken substantially on line **102—102** of FIG. 103, as indicated by the arrows;

FIG. 103 is a horizontal section taken on line **103—103** of FIG. 102, as indicated by the arrows;

FIG. 104 is a vertical section through the rear support for the rammer;

FIG. 105 is a vertical section through the front support for the rammer;

FIG. 106 is a schematic view partly in vertical section and partly in perspective of an intermediate portion of the rammer, said view showing two vertical sections taken in spaced adjacent planes;

FIG. 107 is a schematic view in vertical section of the operating mechanism for the rammer;

FIG. 108 is a schematic view partly in side elevation and partly in vertical section of the breech block and a portion of the operating mechanism therefor;

FIG. 109 is a schematic view partly in side elevation and partly in vertical section of another portion of the breech block operating mechanism;

FIG. 110 is a schematic view in vertical section of another portion of the operating mechanism for the breech block;

FIG. 111 is a schematic view in vertical section of the powder case ejecting mechanism;

FIG. 112 is a schematic view in vertical section of another part of the powder case ejecting mechanism;

FIG. 113 is a schematic partial sectional view of one end of the empty case ejector;

FIG. 114 is a schematic view partly in side elevation and partly in vertical section showing a heating mechanism for the gun shield;

FIG. 115 is a bottom plane view of a portion of the gun shield as indicated by line **115—115** of FIG. 114 looking in the direction of the arrows;

FIG. 116 is a vertical section taken on line **116—116** of FIG. 115, as indicated by the arrows;

FIG. 117 is a view in front elevation of a portion of

the gun shield as indicated by line **117—117** of FIG. 114 looking in the direction of the arrows;

FIG. 118 is a schematic view of a booster mechanism for one of the hydraulic accumulators.

Before proceeding with the detailed description of the various parts of the mount, a general description of the mount in connection with the showing in FIGS. 1, 1*a*, 1*b* and 2 will be given.

As above stated, the mount comprises the magazine which includes two identical magazine devices. Each of these devices comprises the lower casing **20** and an upper casing **24**. A powder case drum **28** is rotatable in each casing **20** and a projectile drum **40** is rotatable in each casing **24**. The powder cases are pushed into the casing **20** and into the powder case drum by the operator. The case is pushed against and past a pair of resiliently mounted doors **51** and the projectiles are similarly pushed into the casings **24** and into the projectile drum through a similar pair of doors **27**. The powder case drums and the projectile drums are rotated or indexed step by step and the round of ammunition comprising the powder case and projectile is brought into alignment with the hoist tubes **1900***a* in the casings **1900** of the lower hoist. Chains **1903** move in the casings **1900** and have pawls **1908** thereon which engage the bottom of the powder case and move the same upwardly in said tubes. The projectile rests on top of the powder case and is moved up by the same.

The lower hoist moves the round comprising the powder case and a projectile into a round-receiving chamber in a carrier **300**. The carrier **300** at its lower end moves within a ring **316** having a circumferential flange supported upon the main deck. The casings **1900** of the lower hoist at their upper ends are also within ring **316**. The carrier rotates on ball bearings **307** about a central column **302** which is secured to a frame **15***a* which depends from and is secured to frame **15** and thus depends from the gun support or mount proper. Carrier **300** has a spider **300***b* adjacent its lower end. Said carrier has round-receiving chambers in casings **326** at each side thereof.

An upper hoist is provided and this comprises the hoist tube casings **301** which are carried by brackets **303** secured to a portion **302***a* of the central column which is in turn secured to frame **15***a*. The casings **301** are 180 degrees apart. The upper hoist thus rotates with the central column and thus with the mount proper on which the gun **10** is mounted. The round of ammunition is transferred laterally by suitable mechanism from the chambers in the carrier **300** to the tubes of the upper hoist in casings **301**. The carrier **300** is rotated so as to bring the round-receiving chambers therein into axial alignment with the tubes of the lower hoist and is latched in such position. After receiving the round the carrier is rotated to bring the chambers therein into lateral or radial alignment with the tubes in the upper hoist and is latched to the upper hoist in this position.

The upper hoist moves the round to and into a cradle **902**. Cradle **902** comprises a generally cylindrical casing open at its receiving end. The cradle when in receiving position is in axial vertical alignment with a tube of the upper hoist and is latched in this position. Said cradle **902** is carried on an arm **900** which is in turn oscillatably mounted upon a journal projecting from and coaxial with the gun trunnion **12***b* so that said arm **900** swings about the axis of the gun trunnion. Arm **900** has pivotally connected thereto an arm **904** which comprises a hydraulic cylinder **904***a* and piston **904***a* so that it is extensible. Arm **904** is pivoted at its other end to the base ring **14**. When the round of ammunition has been transferred to the cradle by the upper hoist, arm **904** is extended and the cradle is swung upwardly to a position adjacent the rear of the gun and with its axis substantially parallel to the axis of the gun. The cradle is guided in this movement by an arcuate guide bar **992**.

The upper position of the cradle **902** is its discharge position and it is then alongside and parallel to the transfer tray **1100** and is latched to the slide **12**. Mechanism is provided to transfer the round sidewise from the cradle **902** into the transfer tray **1100**. The fuse of the projectile is set by the fuse pot **1531** while the round is in the transfer tray. The transfer tray **1100** is then swung down to be coaxial with the bore of gun **10** and the round is then rammed by the rammer spade **1700** from the tray **1100** into the breech of the gun.

The gun **10** and housing **11** have the usual recoil construction and move relatively to the slide **12**. Slide **12** includes large side plates **12***a* and a tailpiece **12***c*. The slide is carried on the trunnions **12***b*. The trunnions are journaled in large side frames **13** which are secured to the base ring **14**. Base ring **14** is a large weldment of general rectangular form with rounded corners. The slide and gun are elevated by a power driven pinion engaging the gear segment **16** secured to the slide.

In FIG. **44***a* the drive mechanism for moving the gun and mount proper in training is shown. The motor **532** and its pump **533** shown in FIG. 43 is mounted on the base frame **14** at the opposite side from that shown in FIG. 1. The shaft **532***a* of motor **532** has connected thereto a worm gear **532***b* which meshes with and drives a worm wheel gear **532***c*. Gear **532***c* is secured to a shaft **532***d* journaled in suitable bearings **532***e* carried in the base frame **14** and said shaft has secured to its lower end a gear **532***f*. Gear **532***f* meshes with an annular gear **532***g* which is secured to the stationary ring **15** which is directly below the base frame **14**. When motor **532** and its shaft **532***a* are driven, gear **532***c* and shaft **532***d* will be rotated. This will rotate gear **532***f* and since it meshes with the stationary gear **532***g* this will cause rotation of the mount proper and the base frame **14** so that the parts carried by said frame including the gun, gun housing and slide will be rotated about the central vertical axis of the mount. This rotation, as stated, is for training the gun.

The base ring **14** has secured thereto the gun house **19** and the latter is provided with observation blisters **19***a*. The gun **10** projects through the gun house **19** and is provided with an arcuate shield **1452**. A large bracket **14***a* depends from base ring **14**.

The various parts of the mount embodying novel features will be separately described.

THE MAGAZINE DEVICE

The magazine device comprises a pair of identical magazines. There is a tube of a lower hoist associated with each of said magazines to which the round of ammunition is delivered. While different kinds or different units of ammunition might be used, in the embodiment of the invention illustrated the round of ammunition comprises a powder case and a projectile. The rounds of ammunition are manually placed in the magazine device. These two individual hoists are similar and are collectively referred to as the lower hoist. Each of said magazines comprises a lower cylindrical casing **20**. This casing has a lower annular peripheral flange **20***a* which is secured to the upper annular flange **21***a* of a flanged ring **21** having a lower annular base flange **21***b* which is supported from the handling room deck by a series of circumferentially spaced brackets **22**. See FIG. 3. Casing **20** has an upper annular peripheral flange **20***b* on which is disposed an annular plate **23** on which in turn rests the lower annular peripheral flange **24***a* of an upper cylindrical casing **24**. Casing **24** has an upper peripheral flange **24***b* which supports a cover **25** shown as having a plurality of radially disposed reinforcing ribs **25***a* which extend from its periphery to a central annular flange **25***b*.

The powder drum

A cylindrical drum **28**, called the powder drum, is disposed within casing **20**, see FIGS. 4 and 7, the same having a central cylindrical portion **28***a*. The drum **28** car-

ries about its periphery a plurality of semi-cylindrical chambers **28***b* formed by generally semi cylindrical casings **28***c*. The chambers **28***b* are adapted to receive the powder cases. There are twenty of the chambers **28***b*. Each chamber **28***b* has a plate **28***d* forming a partial bottom therefor which supports the powder case in its respective chamber **28***b*. The tops of the chambers **28***b* are open. Drum **28** has a gear **29** secured thereto at its bottom and disposed coaxially therewith. Gear **29** meshes with an idler gear **30** carried on a shaft **31** suitably journaled in casing **20**. Gear **30** meshes with another idler gear **32** carried on a shaft **33** suitably journaled in casing **20**. A pinion **34** meshes with gear **32** and is connected to a shaft **35**. Shaft **35** extends upwardly into a sleeve **35***a* to which is secured a pinion **36** meshing with a rack **37**. See FIG. 9. Drum **28** has central hubs at its top and bottom bored to receive ball bearings **38** which also engage a central column **39** about which drum **28** rotates and on which it is supported. Column **39** has a shoulder adjacent its lower end engaging ball bearings **38***a* also supported in a recess formed in the base plate **20***a* of casing **20**.

The projectile drum

A drum **40**, called the projectile drum, is disposed within the casing **24** and has upper and lower central hubs bored to fit central column **39**. Said column has a reduced portion at its upper end disposed in a ball bearing **26** disposed in top plate **25**. Drum **40** is secured to column **39**. A collar **39***a* is carried on column **39** the periphery of which engages an oil sealing ring **38***c* also engaging a collar **28***f* secured to the top of drum **28**. An oil sealing ring **38***b* is disposed between collar **39***a* and the upper end of drum **28**. The bearing **38** is oiled from the side through a tube **41**. The projectile drum **40** is coaxial with powder drum **28**. Drum **40** has about its periphery a plurality of casings **40***b* of general semi-cyclindrical form and each forming a chamber **40***c*. There are twenty of the chambers **40***c* and these chambers are open at both top and bottom. Drum **40** and the portions **40***b* at their lower ends rotate closely adjacent the plate **23** which is of annular flange-like form and extends some distance inwardly between casings **20** and **24** and beneath the chambers **40***c*. Plate **23** supports the projectiles in chambers **40***c*. Plate **23** is solid except for an opening at the hoisting position which is in alignment with one of the lower hoist tubes. The upper drum has secured to the lower portion of central column **39** a gear **42**. An idler gear **43** meshes with gear **42**, the same being mounted upon a shaft **44** suitably journaled in casing **20**. A pinion **45** meshes with gear **43**, which pinion is secured to a shaft **46** which extends into a sleeve **120** which also has secured thereto a pinion **47**. Pinion **47** meshes with a rack **48**. The racks **37** and **48** and thus pinions **36** and **47**, are actuated to rotate or index the drums by identical control means which will be later described. The powder and projectile drums are rotated in opposite directions.

Powder drum magazine shutters

Each casing **20** has an opening **20***c* in the side thereof extending between flanges **20***a* and **20***b* and having vertical flanges **20***d* at each side thereof. Brackets **21***c* are secured to and project outwardly from ring **21** and are provided with vertical bores in which are journaled lower reduced trunnion-forming portions **51***a* of swinging magazine doors or shutters **51**. Said shutters have upper reduced trunnion portions **51***a***1** coaxial with portions **51***a*, which are journaled in bores in a bracket **50** which is suitably secured, as by bolts, to annular plate **23**. As shown in FIGS. 3 and 7, the shutters **51** are disposed at opposite sides of the opening **20***c* and normally are directed inwardly toward each other. This is their normal or closed position. Said shutters have vertically spaced inwardly extending portions **51***b* which extend close to openings **20***c*. See FIG. 7. These portions **51***b* act to substantially close opening **20***c*.

The shutters are connected for simultaneous swinging action about the axis of their upper and lower trunnions and for this purpose doors **51** have connected thereto respectively arms **51***c* and **51***d* extending radially from the axes of their trunnions. See FIG. 10. One arm **51***c* extends outwardly or away from casing **20**, while the other arm **51***d* extends inwardly. Arm **51***d* extends inwardly. Arm **51***d* has pivotally connected thereto by a pivot **53**, a link **54**. Link **54** is pivotally connected at its other end, by a pivot **55**, to arm **51***c*. Link **54** extends through a cylindrical cup-like member **21***d* which is secured to and forms part of bracket **21***c*. Member **21***d* is thus held in stationary position. At one end, member **21***d* is slightly recessed to receive and be engaged by the end of a resilient block **56** having a plate or washer **57** at one end and held in place on link **54** by a pair of lock nuts **58** threaded into a reduced portion **54***a* of link **54**. Portion **54***a* extends through block **56** and is surrounded by a coiled compression spring **59** which engages block **56** at one end and at its other end engages a shoulder formed by a portion **54***b* of link **54**. Link **54** has a flange or collar **54***c* adjacent one end and a coiled compression spring **60** surrounds portion **54***b*, the same engaging collar **54***c* at one end and at its other end engaging the inside surface of the end of cup-like member **21***d*. Link **54** has a portion **54***d* extending from collar **54***c* and substantially fitting in the end of spring **60** to hold the same in position.

From the above described construction it will be seen that when one door **51** is swung inwardly, the other door will also simultaneously swing inwardly. Said doors are thus connected for simultaneous swinging movement by link **54**. The powder cases are held by the operator and pushed inwardly against portions **51***b* of doors **51** and through the opening **20***c*. A plate **52** projects outwardly from opening **20***c* having its top surface in the same horizontal plane as the top of plates **29***d*. The powder cases can rest on plate **52** and then be pushed inwardly. The doors **51** are swung inwardly by this operation and when the case has been pushed into drum **28** and into one of the chambers **28***b*, the doors **51** will be released and they will be returned to their normal positions by springs **59** and **60**. The powder cases are thus loaded into drum **28** by the operator who pushes them past the doors **51**.

Indexing latching means

When the powder case has been pushed through the doors **51**, a latch is operated which must be manually released before the drum **28** can be indexed. For this purpose a switch box or casing **64** is secured to casing **20**, the same having therein a pair of latching switches IA4A and IA4B (see FIG. 13). A plunger **67** is slidable in bearings in casing **64**, the same being held in the projected position shown in FIG. 13 by a compression coiled spring **69** which engages at one end with one side of bearing **68** and at its other end engages an enlarged portion of plunger **67**. Switches IA4A and IA4B have operating plungers and which are engaged by a tapered portion **67***b* of plunger **67**. When the operator pushes the powder case between shutters **51**, said shutters are swung inwardly and one of them engages and moves plunger **67** longitudinally and inwardly and said tapered portion **67***b* engages said switch plungers and actuates said switches. When plunger **67** is so moved inwardly, a swinging latch member **70** carried on a shaft **71** journaled in casing **64** is moved into position at one side of a projection **67***c* on plunger **67** and said plunger is thus locked in its inward position. Member **70** is moved to its locking position by a coiled compression spring **72** in casing **64**. Shaft **71** projects at one end of casing **64** and has secured thereto a handle member **73**, shown in FIG. 7 as in the form of a plate. When plate **73** is pushed upon by the operator, shaft **71** is oscillated and stop member **70** is swung away from the projection **67***c*

so that plunger **67** is released and can be projected outwardly by spring **69**. Switches IA4A and IA4B are then spring actuated and the drum **28** is released for indexing. Only one of said switches is effected, the other being a spare. Said switch thus indicates that the latch is released and indexing can proceed. The described mechanism insures that the operator's hands will not be caught by shutters **51** in the indexing movement of drum **28**.

Manual door latch

A bracket **80** is fixed to one of the doors **51** adjacent the upper end thereof, the same having spaced portions between which a lever **81** is disposed and to which it is pivoted by the pivot member **82**. Lever **81** is equipped with a ball handle at one end and at its other end has a tongue **81***a* adapted to be received in either one or two slots **45***a* in plate **45**. When tongue **81***a* is disposed in the slot **45***a* closest to casing **20**, the doors will be locked in normal or closed position. When the doors **51** are moved inwardly, tongue **81***a* will come into alignment with the slot **45***a* remote from casing **20** and be moved thereinto to hold the doors **51** in inward or open position. Lever **81** is used in manual operation only. It is used to manually open doors **51** when the mount is in manual operation and is not used when the mount is in power operation.

Drum shutter latch

The doors **51** are locked in their normal position when the drum **28** is indexing so that no powder case can be loaded into the drum during the indexing. (See FIG. 12.) For this purpose a solenoid casing **90** is secured to casing **20**, the same having therein a solenoid SA3 having a core plunger **92** which projects beyond one end of casing **90** and at its outer end is connected to one end of a latch lever **93** carried on a stud **94** secured to casing **20**. A compression coiled spring **95** engages a portion of casing **90** and at its other end engages a collar **96** on core plunger **92**. When solenoid SA3 is energized, core plunger **92** will be moved inwardly, and when said solenoid is de-energized, spring **95** will move core plunger **92** to its outer position. The other end of lever **93** is formed as a latch, the same having a projecting lip **93***a* adapted to be swung under a latching arm **51***e* on one of the doors **51**. When solenoid SA3 is energized, plunger **92** is moved to the right, as shown in FIG. 11, bringing latch portion **93***a* into engagement with latch arm **51***e*. Doors **51** can thus not be swung during the indexing of drum **28**. Plunger **92** is connected to an arm **99** oscillatable about the axis of a stud **100** disposed in casing **90**. Arm **99** is disposed to engage a switch actuating plunger **101***a* of a switch IA103A and operate said switch when plunger **92** is moved inwardly. Switch IA103A thus indicates that the doors **51** are now in locked position and indexing may proceed.

Projectile drum magazine shutter and latches therefor

Each casing **24** is provided with an opening **24***c* in the side thereof extending between flanges **24***a* and **24***b* and having vertical flanges **24***d* at each side thereof. A pair of doors or shutters **27** are provided having coaxial trunnions **27***a* at their tops and bottoms which are mounted respectively in bores in brackets **49** and **55**, which brackets project from casing **24** above and below opening **24***c* respectively. The shutters **27** are similar in all respects to doors **51** already described. They are connected for simultaneous swinging movement and for returning movement to normal position by a mechanism **41** which is identical with the mechanism shown in FIG. 10 and which need not be further described.

A shelf **60** is provided and forms an integral part of annular plate **23**, the same projecting outwardly from opening **24***c*. One of the doors **27** has associated therewith a hand lever **61** which is similar in all respects to hand lever **81** and cooperates with slots (not shown) in bracket **49** to hold doors **27** in open position. Lever **61** is used only in manual operation of the mount.

The projectile is pushed through doors **27** by the operator and it may initially rest on shelf **60**. When the projectile has been pushed through the doors **27**, a latch is operated which must be manually released before drum **40** can be indexed. This latch and its operating mechanism is contained in a casing **75**, see FIG. 7, and is identical with the latch and mechanism for doors **51** in casing **64** and need not be again described. Said mechanism prevents the operator's hands being caught in shutters **27** by indexing of drum **40**. The doors **27** are locked in normal position when drum **40** is indexing so that no projectile can be loaded into said drum during indexing. The mechanism for this is the same as for doors **51** and is largely contained in a casing **76**. (See FIG. 7.) Said mechanism includes a switch and solenoid (not shown) in casing **76**, identical with the similar parts in casing **64**, which solenoid is energized during indexing to hold shutters **27** locked in normal position.

Unloading door for powder drum

The casing **20** is provided with an elongated vertically-extending opening, which opening extends substantially between plates **20***a* and **20***b*. Said opening is closed or exposed by a door **129** carried on hinges **131** secured to the casing **20**. Door **129** has projecting lugs **129***a* having central slots in their outer ends into which locking handles **132** can be disposed, as shown in FIG. 7. Said handles **132** have a collar **132***a* thereon of somewhat larger diameter than the width of said slots which engages the outer side of lugs **129***a*. Said handles **132** are pivoted on vertically extending pins **135** carried in brackets **139** secured to the outer side of hoist casing **1900**. The opening in casing **20** closed by door **129** is in alignment with and communicates with one of the hoist tubes of the lower hoist. Said opening and door **129** are provided to unload the drum **28** and the chamber **28***c* thereof, which is in alignment with the hoist tube.

Switch indicating powder case in drum

An arm **151** is disposed in the casing **20** or its ring **21** having a roller **151***a* at its end which is normally disposed with its top some distance above the top surface of the bottom plate **28***d*. Arm **151** is secured to a shaft **152** to which another arm **153** is connected. Arm **153** is engaged by a coiled compression spring **156** and held against a roller **157** carried in the end of an arm **159** which is the actuating arm for a switch IA1A,B,C,D. When a powder case is in the chamber **28***c* aligned with the hoist tube and thus in hoisting position, the same will engage roller **151***a* and swing arm **151** downwardly, thus swinging arm **153** downwardly against the pressure of spring **156**. This will permit actuation of switch IA1A,B,C,D which will indicate that there is a powder case in the hoist position.

Projectile unloading door

Another opening is provided in casing **24** extending vertically therealong for substantially the entire height of casing **24**, and is closed by a door **141** carried on hinges **148** secured to casing **24**. Door **141** has lugs **141***a* at its free edge adapted to receive and be engaged by locking handles **143** which are identical with handles **132** already described except that the same have thereon disks **143***a* having one or more ratchet notches in their peripheries adapted to receive the tongues of pawls **143***b* which may be spring pressed. Pawls **143***b* hold handles **143** in locked position and are mounted in brackets **149** secured to casing **24**. (See FIG. 8.) The opening closed by door **141** also communicates with and is in alignment with one of the hoist tubes of the lower hoist and is provided so that a projectile can be unloaded from said hoist tube. Means for operating door **141** will be later described.

Means for depositing projectile on powder case

When a projectile is moved into registry with the lower hoist tube it is moved onto a plate **161***a* which is supported by and pivoted to a vertically extending plate **161** and which is at the outer side of plate **161**. (See FIGS. 7 and 15.) As shown in FIG. 15*a*, a casing **162** is disposed in casing **24** having side walls or plates **162***a* and a rear wall **162***b*. Plate **161** is swingable upwardly and inwardly about pivots **160** and **168**. Pivots **160** and **168** are journaled in bearings **162***c* and **162***d* respectively in the side walls **162***a*. A pair of arms **166** are journaled in a bearing **161***j* on the inner side of plate **161** and extend inwardly therefrom, being connected at their ends by a tube **166***a*. The shaft or pivot **168** extends through and is secured to tube **166***a* and has portions at the ends of said tube journaled in bearings **162***d* in side walls **162***a*, and forming the fulcrum for arms **166**. A cam **168***a* is carried by shaft **168** and disposed to engage a roller **169** carried on an arm **173** forming the actuating arm of a switch IA3A,B. Plate **161** has a portion **161***b* extending inwardly from bearing **161***j* and having extending spaced plate-like portions **161***e* at its inner end. A pin **161***d* is carried in the upper end of a link **167** and has attached thereto one end of a lever **170**. Lever **170** has a central portion which is bored to receive a pin **174** carried by portions **161***e*. Pin **174** forms the fulcrum of lever **170**. The inner end of lever **170** is arranged to engage an arm **175** which is carried on a shaft **176** to which is secured an arm **177**. Shaft **176** is journaled in a bearing **162***c* in one side wall **162***a*. Said inner end of lever **170** comes into engagement with arm **175** when plates **161** and **161***a* are in their lower positions with plate **161***a* in the hoist tube. This is the position of plate **161***a* shown in FIGS. 7 and 15. Arm **177** has a hub at its outer end bored to receive a pin **177***a* beneath which is a compression spring (not shown). Pin **177***a* is engaged by a roller **178** carried at the end of the actuating arm **179** of a switch IA5A,B,C,D. Plate **161***a* is pivotally mounted on a shaft **180** journaled in plate **161** and has a projecting portion **161***c* which carries a pin **183**. Link **167** is connected at its lower end to pin **183**. Plate **161** has outwardly projecting lugs **161***h* adjacent its bottom having lower surfaces which form stops and which come into engagement with yielding members **194** on casing **24** when plates **161** and **161***a* are in their inner and lower positions. In practice members **194** have been nylon disks.

Plate **161** has a lug **161***g* at its rear side through which extends a pivot pin **181**. A pair of arms **182** are swingable about pin **181** and are connected intermediate their ends by a pin **182***a*. Arms **182** as shown are connected by a web integral therewith. At their outer ends, arms **182** have the shaft **160** extending therethrough having portions forming fulcrums for arms **182**. Said portions of shaft **160** are journaled in bearings **162***c* formed in the side walls **162***a* (see FIG. 15*a*). A member **184** surrounds pin **182***a* and extends upwardly therefrom, the same having a collar thereon the upper side of which is engaged by a compression coiled spring **185**. The upper portion of member **184** is provided with a bore into which extends the lower end of a member **186** having a collar thereon the lower surface of which is engaged by spring **185**. The portions of members **184** and **186** between said collars thereon are also disposed within the spring **185**. Member **186** is pivotally connected at its upper end to a bell crank lever **187** adapted to swing about a fulcrum pin **187***a* which will be journaled in bearings **162***f* in side walls **162***a*. Lever **187** has an upwardly extending bifurcated arm in which is journaled a roller **188**. Roller **188** is preferably made of rubber or similar yielding material. One of the arms **182** has an outer extension to the end of which is secured the lower end of a tensile coiled spring **189** the upper end of which is secured to a stationary pin **190***a* carried on a bracket **190** projecting from door **141**. An arm **191** is secured to a shaft **191***a* journaled in a bearing in door **141** and the same has a handle **191***b* at its outer end. An arm **195** is secured to shaft **191***a* and has journaled at its end a roller **193** which engages the underside of one of the arms **182**.

The lower hoist has a lifting pawl, to be later described, which moves through the hoist tube and engages the bottom of the powder case disposed in the chamber **28***b* which is aligned with a hoist tube. The powder case is moved upwardly by said pawl and engages the bottom of plate **161***a* on which the projectile at the hoist position is resting. Plate **161***a* is pushed upwardly and this causes the same and plate **161** to swing upwardly and rearwardly as arms **166** and **182** swing about the axes of pivot shafts **160** and **168**. This upward and outward swinging movement withdraws plate **161***a* from beneath the projectile and said projectile then moves downwardly by gravity so that it engages and rests upon the top of the powder case and is moved upwardly thereby. There is a projecting rim at the bottom of the powder case which would engage the inner edge of plate **161***a* as said case is moved upwardly. To prevent this the lever **187** and roller **188** are prvided. The powder case engages the inner side of roller **188** and forces the same outwardly. This swings lever **187** and puts a downward and outward pressure through spring **185** on members **184** and **186** which causes a further swinging movement of plate **161**. It will be seen that plate **161** is already in an outer position and the lines connecting the pivot **187***a* and the axis of shaft **168** with the axis of pin **182***a*, as shown in FIG. 15, meet in an obtuse angle. Members **186** and **182** form in effect a toggle. When the powder case has passed roller **188** the parts are moved back to their normal position by spring **189** and lever **187** is moved to its normal position by spring **185**. When plate **161** is swung upwardly and outwardly, cam **168***a* engages and moves roller **169** and arm **173** actuating switch IA3A,B. Switch IA3A,B thus indicates that indexing should not take place. When plates **161** and **161***a* swing back to their lower position shown in FIGS. 7 and 15, switch IA3A,B is again actuated. Said switch then indicates that indexing of drums **28** and **40** may proceed. When plate **161** swings outwardly and upwardly, portions **161***d*, and lever **170** move with it so that lever **170** moves away from arm **175**. When plates **161** and **161***a* swing back to their lower position, lever **170** again engages arm **175**. Plate **161** and parts carried thereby comprise a large mass and they drop back quickly with quite a shock. Lugs **161***h* and yielding stop members **194** are provided to relieve said shock.

When a projectile is moved onto plate **161***a* the weight thereof swings said plate downwardly about the axis of shaft **180**. This swings pin **183** and link **167** upwardly, oscillating lever **161***f* about pin **174** and depressing arm **175**. This oscillates shaft **176** and arm **177** thus actuating switch IA5A,B,C,D. Switch IA5A,B,C,D then indicates that a projectile is in hoisting position in the hoist tube.

When it is desired to open door **141** for unloading the hoist, the operator will swing crank handle **191***b* downwardly. As shown in FIGS. 7 and 15*a*, handle **191***b* is disposed at the outer side of door **141**. This will swing arm **195** upwardly so that roller **193** will engage arm **182** and arms **182** and plates **161** and **161***a* will swing upwardly and outwardly about the fixed pivots **165** and **168** just as they do when plate **161***a* is moved by a powder case. The operator can then swing the door **141** to open position. The projectile can then be removed. This is only done when the hoist is being unloaded by being moved in reverse or run backward.

Drum indexing means

Referring to FIG. 9, the gear **47** which meshes with rack **48** is cut integrally with a clutch sleeve **120**. Sleeve **120** is mounted for rotation on shaft **46**. Member **120** has clutch teeth **120***a* at the end opposite gear **47** which are adapted to engage with teeth **121***a* in a clutch member **121** which is splined on and slidable on a portion of

shaft 46. Clutch 121 also has teeth 121*b* on its other end adapted to engage with teeth 122*a* on a stationary member 122 which is secured to a portion 123 of the stationary frame. Clutch 121 has spaced collars forming an annular groove in which are disposed at opposite sides thereof rollers 124 carried on studs 125 secured respectively in the spaced sides of one arm 126*a* of a bell crank lever 126 which is pivoted on a stud 127 secured to an arm of the valve block 130. The other arm of bell crank lever 126 comprises a plate portion 126*b* in position to engage the actuating plungers of switches IA9A and IA9B. Arm 126*a* carries a portion having therein spaced recesses 126*d* either of which is adapted to receive a spring pressed detent 133 carried in a block 134. Bell crank lever 126 has one arm connected by a link 136 to another link 137 forming a toggle with a link 138. One end of link 137 is connected to a lug 130*a* secured to block 130. Link 138 is pivoted at one end to link 137 and the same is pivoted at its other end to the valve rod of a valve 140 which is movable in a bore 130*b* in valve block 130. Valve 140 has one land 140*a* adapted to control the ends or parts of passages 130*c*, 130*d* and 130*e*. Passage 130*c* leads to the end of a bore 130*f* in which is slidable a piston 142 to which is connected one end of rack 48. Valve 140 also has adjacent one end a land 140*b* adapted to control the end or port of a passage 130*g*. A passage 130*h* communicates with one end of bore 130*b* and is adapted to receive fluid under accumulator pressure hereinafter referred to as PA. Passage 130*d* extends to and has its end communicating with a bore 130*i* in which is movable a valve 144 the end of which carries a roller 145 which is held in engagement with a cam 146 on clutch member 120 by a compression coiled spring 147 in bore 130*i*. Passage 130*g* has at its other end a port communicating with a bore 130*j*. Passage 130*e* communicates with a passage 130*k*, one end of which communicates with bore 130*j*. Bore 130*j* has movable therein a valve 150, the same having three lands 150*a*, 150*b* and 150*c*. A passage 130*n* communicates with bore 130*j* and will be connected to a conduit extending to tank. Land 150*a* has a bore therethrough communicating with passage 130*n* and communicating with the space between lands 150*a* and 150*b*. A passage 130*o* extends from bore 130*j* to passage 130*h*. A passage 130*p* extends from the end of bore 130*j* opposite that with which passage 130*n* communicates, to a passage 130*q*. Passage 130*q* communicates at one end with a valve chamber 130*i* in the rear of an end land of a valve 144 and in which portion a spring 147 is disposed. The other end of passage 130*q* communicates with a valve chamber 130*r* in which is disposed a valve 154 having spaced lands and being urged to one position by a compression coiled spring 155. A restriction is disposed in passage 130*q* adjacent chamber 130*r*. A passage 130*s* communicates with chamber 130*r* at one end of valve 154 and communicates with chamber 130*i*, a certain restriction being disposed therein at one side of chamber 130*i*. Another passage 130*v* connects the lower side (FIG. 9) of chamber 130*i* to chamber 130*r*, passage 130*v* also having a restriction therein. Rack 48 has a rod at the side opposite valve 142 which is connected to a piston 142*a* movable in a bore 130*t* of block 130. Passage 130*k* communicates with bore 130*t* adjacent the closed end thereof and said passage is equipped with a spring pressed check or ball valve 170. A passage 130*u* extends from bore 130*t* to passage 130*k* and by-passes the valve 170. Valve 150 has a valve rod extending from block 130 and pivotally connected to an oscillating lever 158 pivoted on a stud 159. Lever 158 has a semi-cylindrical portion provided with spaced recesses 158*a* and 158*b*. A spring pressed detent 157*a* is adapted to engage in either of said recesses to hold lever 158 in either of its positions, said detent being mounted in a stationary block 157. Solenoids SA5 and SA4 are provided, having plungers 163*a* and 163*b* respectively which are pivotally connected respectively to oppositely extending arms of lever 158. Said plungers project somewhat from lever 158 and are adapted to cooperate with an actuate respectively when in certain positions, switches IA105A and IA104A. Clutch sleeve 120 has secured thereto a cam 171 having a cam portion adapted to engage respectively the actuating plungers of switches IA6A and IA11A disposed at opposite sides of member 120.

A valve block 180 is provided which is similar in all respects to valve block 130 and functions in the operation of shaft 35. In FIG. 9 a passage 180*a* is shown in block 180 which corresponds to passage 130*k*, and a bore 180*b* is shown which corresponds to bore 130*f*. A piston 181 is shown which corresponds to piston 142 and rack 37 will have a piston at its other end corresponding to piston 142*a*. Part of a passage 180*c* is shown which corresponds with passage 130*c*.

The motive force for indexing the drum 40 is furnished by piston 142*a* which, as shown in FIG. 9, moves rack 48 and turns gear 47, thus turning shaft 46, rotating gears 45 and 43 and thus gear 42 which is attached to drum 40. The full stroke of piston 142*a* causes the clutch member 120 to revolve 180 degrees. Such revolution of member 120 through the reduction of the gear train 45, 43 and 42 rotates or indexes drum 40 eighteen degrees which is the angular or circumferential distance or spacing between adjacent ammunition chambers 40*c*. Clutch 121 can engage sleeve 120 or member 122 at either of two positions which are 180 degrees apart. When clutch sleeve 120 is engaged with clutch 121, piston 142*a* can rotate drum 40. When clutch 121 is engaged with clutch 122 the shaft 46 and drum 40 are locked in stationary position. The clutch teeth 121*a* on clutch 121 begin to engage the clutch teeth 120*a* on clutch sleeve 120 before the clutch teeth 121*b* are disengaged from the clutch teeth 122*a* on stationary member 122 so that drum 40 is either controlled by piston 142*a* or it is locked in stationary position.

Indexing operation

An indexing cycle of drum 40 which is the right-hand projectile drum occurs as follows. When the manually operated switches which are on a panel at the Gun Captain's position, are set for automatic operation, switch IA5A,B,C,D is closed indicating that no projectile is present in the hoist position. Switch IA3A,B is closed indicating that the projectile support 161*a*, is extended. Switches IA7A and IA103A are closed indicating that the doors or shutters 27 and 51 are closed and in the position shown in FIGS. 7, 11 and 12. Switches ID3A,B,C,D,E and ID4A,B,C are closed indicating that the hoist is latched and cannot be operated and insuring that the chain pawls 1908 will not interfere with the operation of drum 40. Switch IA6A is closed insuring that the rack 48 is fully retracted. When all of said switches are operated an electrical circuit is closed and solenoid SA4 is now energized. This swings lever 158 moving valve 150 to the right from its position, as shown in FIG. 9. The lower portion of valve 140 forms a dash pot. When PA is applied through 130*g*, valve 140 is raised slightly against atmospheric pressure and the fluid can then act on bottom of valve 140. PA supplied to passage 130*h* now enters pasage 130*o* and moves between the lands 150*b* and 150*c* to passage 130*g* and to bore 130*b* below the land 140*b* of valve 140. Valve 140 now is moved upwardly and through the links 138, 137 and 136, bell crank lever 126 is rotated in a counterclockwise direction which moves clutch 121 downward into engagement with clutch sleeve 120. As valve 140 moves upward and completes its stroke, it admits PA to the left end of piston 142*a* causing said piston to move to the right, as shown in FIG. 9, and move rack 48 to rotate or index drum 40. Said PA passes from passage 130*g*, around valve 140 to passage 130*e*, thence to pas-

sage 130*k*, and thence to bore 130*t*. As piston 142*a* completes its stroke it is decelerated by the cam acuated valve 144. As valve 144 is moved to the right by cam 146 (FIG. 9), it closes passage 130*v* causing a drop of pressure in bore 130*r* and valve 154 is now moved to the left by the pressure at the right thereof, closing the end of passage 130*q* at bore 130*r* and gradually cutting off the venting of fluid from bore 130*r* to tank through passages 130*q* and 130*p*. The fluid at the right of piston 142 passes out through passage 130*c*, around valve 140*a* (now up) to passage 130*d* to valve chamber 130*i* to valve chamber 130*r*, passage 130*q* to passage 130*p* to tank passage 130*n*. Movement of rack 48 to the right is thus decelerated. When pistons 142*a*, 142 and rack 48 reach their limit of movement to the right, switch IA11A is closed by cam 171 and this energizes solenoid SA5 and shifts valve 150 to the postion shown in FIG. 9. PA now passes through passage 130*h* to bore 130*b* at the top of valve 140 and said valve is moved to its lower position, as shown in FIG. 9. Passage 130*g* at the bottom of valve 140 is now vented to tank, as shown in FIG. 9. When valve 140 is thus moved downward, clutch 121 is raised by movement of links 138, 137, 136 and bell crank 126 moves clutch 121 out of engagement with sleeve 120 and into engagement with stationary member 122. PA is now admitted to the right-hand end of bore 130*f* and of piston 142 through passage 130*c*, bore 130*b* and passage 130*h*, and piston 142 is returned to its original position shown in FIG. 9. As piston 142, rack 48 and piston 142*a* are thus moved to the left, check valve 170 closes and fluid is forced through the restricted passage 130*u* and piston 142*a*, rack 48 and piston 142 are decelerated and reach their limit of movement. The control is now prepared for another indexing cycle. If a loaded chamber has been indexed to the hoisting position a hoist cycle will take place before the drum is again indexed. If an empty chamber 40*c* has been indexed to the hoisting position, the control will perform another indexing cycle and will continue to repeat the same until the hoist position is loaded.

LOWER HOIST

A lower hoist is provided which moves a round of ammunition from a magazine device to the carrier. This lower hoist comprises two hoist casings, there being one casing for each of the loaders. As shown in FIGS. 1 and 3, each hoist casing 1900 which includes the hoist tube 1900*a* extends along the side of the casings 20 and 24 of the two magazines respectively and the same extends quite a distance below casing 20. The hoist casing and tube also extend quite a distance above casing 24, and as shown in FIGS. 1 and 2 extend to the carrier. Each hoist casing has therein a hoist chain 1903 which runs over an upper sprocket 2000 secured to and driven by a shaft 2001. Shaft 2001 is journaled in ball bearings 1905 in the housing. As shown in FIGS. 7, 16, 17 and 18, the hoist casing is divided along a central plane and the parts thereof are connected by headed and nutted bolts 1906. The chain has secured thereto pawls 1908 which project into the hoist tube 1900*a* and engage the bottom of the powder cases to move the same and the projectiles upwardly through tube 1900*a*. Pawls 1908 comprise the step portion 1908*a* which engages the powder case and which is pivoted to a lug 1903*a* on one of the links of chain 1903. See FIGS. 19 to 24. Portion 1908*a* is also pivoted to a link 1908*b* which is pivoted to a lug 1903*b* on one of the links of chain 1903. Chain 1903 also carries a lug 1903*c* which engages one side of the projectile PJ and holds the same close to the side of hoist tube 1900*a*. A projectile guide 1909 is provided and comprises a plate 1909*a* having a lug pivoted by pivot 1905 to a link 1903*e* of chain 1903. Plate 1909*a* is pivotally connected adjacent its other end to a link 1903*f* of chain 1903 by a link 1906. A portion 1909*b*, having its side remote from chain 1903 tapered, is slidable longitudinally on plate 1909*a* and is provided with a threaded lug 1909*c* through which passes a screw 1907 journaled in a lug 1909*a*1 at one end of plate 1909*a*. Screw 1907 has a head engaging said latter lug, a portion of which is of hexagonal form, to receive a wrench for turning screw 1907. A washer 1907*a* on screw 1907 engages the other end of lug 1909*a*1 and is in turn engaged by a nut 1907*b* threaded on screw 1907. Said head on screw 1907 has a plurality of circumferentially spaced recesses, with which a spring pressed detent 1907*c* cooperates to hold screw 1907 in adjusted position. By turning screw 1907, portion 1909*b* can be moved longitudinally to bring its tapered side into the desired engagement with the side of the ogive of the projectile PJ. Chain 1903 also passes around a lower sprocket 1910 which is rotatable on ball bearings 1911 supported upon a central disk 1912 which is eccentrically supported on and secured to a shaft 1914 journaled in hubs 1900*b* of the housing casing. An arm 1915 is journaled on one end of shaft 1914 without the hoist casing and has a stud 1916 secured thereto at its other end which extends through a slot 1900*c* in the hoist casing and is secured to the disk 1912. As shown in FIG. 16, a member 1917 is secured to the end of arm 1915 to which member 1916 is secured, and member 1917 is engaged by a compression coiled spring 1919 which is also engaged by a plate 1920 carried on an arm 1921 pivotally secured to a bolt or pin 1923 in the outer side of the hoist casing. Plate 1920 can be adjusted by a nut 1924 threaded on member 1921 to vary the compression of spring 1919. It will be seen that spring 1919 will move or oscillate arm 1915 and move the disk 1912 about the center of shaft 1914 and relatively to the sprocket 1910. This will act to move the sprocket downwardly and thus to tighten the chain 1903. As shown in FIG. 16, the hoist casing is also divided along transverse planes into several sections which are bolted together.

The chain of the hoist is driven by the upper sprocket 2000. Sprocket 2000 is driven by a shaft 2001 and a brake 2002 is interposed between said shaft and sprocket. See FIGS. 25 and 27. Brake 2002 comprises a brake casing 2002*a* of general cylindrical form in which is disposed a plurality of driven steel disks 2002*b* between which respectively are molded disks 2002*c* suitably supported from casing 2002*a*. Said disks are brought into engagement to set the brake by a plurality of circumferentially spaced shell-like plungers 2002*d* which are urged against the end disks by compression coiled springs 2002*e* disposed within members 2002*d*. Rods 2002*f* extend axially through members 2002*d* and springs 2002*e* and are connected to members 2002*d* for moving the same away from the disks. The brake is normally set or urged to operative position by the springs 2002*e*. The disk assembly is slightly compressible and the disks have sufficient resiliency to release when pressure is removed. The brake brings the hoist to a stop in event the regular control fails properly to decelerate the hoist and round of ammunition moved thereby, when the latter enters the carrier, and as the hoist pawl nears its upper limit of movement. The brake is set at times when the hoist is not in use. The rods 2002*f* at their ends are connected to a ring 2004 extending through and having a flange 2004*a* disposed to be engaged by a yoke ring 2005 which is pivoted at one side by a pivot 2003 for swinging movement in a substantially axial direction. At the side opposite its pivot, ring 2005 has pivotally connected thereto a link 2006 which is connected at its other end to a lever 2007 pivoted at one end to the stationary casing 2008 and at its other end pivotally connected to a link 2009. See FIGS. 25 and 27.

Manual lowering of hoist

The shaft 2001 is driven through reducing beveled gears 2012 by a shaft 2014 in turn driven by the hydraulic

motor 2015. Provision is made for manually lowering the hoist and for this purpose a wormwheel gear 2016 is secured to shaft 2014 adapted to be engaged by a worm 2017 secured to a shaft 2018 which is swingable transversely of its axis and about a semi-spherical bearing in a stationary member 2019. Shaft 2018 has at one end a crank handle 2020. As shown in the hydraulic schematic FIG. 27, worm 2017 is out of mesh with one side of wormwheel gear 2016. As shown in the mechanical schematic FIG. 25, link 2009 is pivotally connected at its end opposite lever 2007 to a bell crank lever 2021, which lever is pivotally connected by a link 2023 to an arm 2024 secured to a shaft 2025 to which is also secured a lever arm 2026. Lever arm 2026 is connected to a link 2027 which is pivotally connected at its other end to a yoke 2022 embracing shaft 2018.

With the described construction it will be seen that when shaft 2018 is swung to bring worm 2017 into mesh with wormwheel gear 2016, shaft 2025 will be oscillated by link 2027 which will through arm 2024, link 2023 and lever 2021 move link 2009 and swing lever 2007 to move ring 2005 away from the brake casing 2002*a*. This will move the rods 2002*f* and move plungers 2002*d* away from the disks 2002*b* and 2002*c*, thus compressing springs 2002*e* and releasing the brake. Crank 2020 can now be rotated and shaft 2014 will be rotated through the worm 2017 and gear 2016 so that shaft 2001 will be rotated to lower the hoist. All of the connections between shaft 2024 and link 2009 are not shown in the hydraulic schematic FIG. 27. In the hydraulic schematic FIG. 27, link 2009 is shown as connected directly to arm 2024 connected to shaft 2025. The brake 2002 is released hydraulically when the hoist is being power operated, as will be later described.

A shaft 2030 extends parallel to shaft 2014 and is driven from the latter through beveled gears 2028, a shaft 2029 and beveled gears 2031, so that shaft 2030 rotates at one-seventh of the speed of shaft 2014. Shaft 2014 has secured thereto spaced latching disks 2032 and 2033. Latches or latching pawls 2034 and 2035 cooperate respectively with disks 2032 and 2033 and engage shoulders or faces on the peripheries of the latter. Latch 2034 is the "lower" latch and releases the hoist for manual lowering. This latch also prevents any movement of the hoist during idle periods. Latch 2035 is called the "hoist" latch and it stops the hoist at the end of a hoisting cycle. Latches 2034 and 2035 are carried on an oscillatable shaft 2036 and the operation thereof will be later described. Shaft 2030 has secured thereto a number of spaces cams 2030A, 2030B, 2030C, 2030D, 2030E, 2030F, 2030G and 2030H. Cam 2030B engages a roller 2035C on an arm of latch 2035 for moving said latch. Cam 2030A engages a roller 2034C on an arm of latch 2034 for moving said latch.

Means to place hoist in manual or automatic operation

An arm 2152 is secured to shaft 2025 already described and has a handle 2153 connected thereto in which is disposed a compression coiled spring (not shown) which engages the end of a shaft 2154. (See mechanical schematic FIG. 25). Shaft 2154 is connected to a member 2156 having a flat central portion and having a shaft 2157 secured to the end thereof opposite shaft 2154 and coaxial with shaft 2154. A compression coiled spring 2158 surrounds shaft 2157, the same engaging at one end a collar 2159 carried on the hoist housing, and at its other end engaging one end of member 2156. Collar 2159 has a short section of shaft secured thereto disposed in spring 2158 and adapted to abut the end of shaft 2157. A pin 2161 extends through the flat central portion of member 2156 and is secured to a disk 2162 secured to a shaft 2163 to which is also secured an arm 2164 positioned to engage the actuating plunger of a switch ID2A. Switch ID2A indicates that the hoist is in position for power operation. Arm 2152 has a lateral projection at its upper end with a top curved surface and said projection has formed therein a recess 2152*a*. Arm 2152 also is provided with a portion 2152*b* having a curved slot 2152*d* with a closed end therein. The bottom of slot 2152*d* is formed as a cam as indicated in dotted lines in FIG. 25. A valve 2060 to be later described extends from the end of a valve chamber 2058 and carries a roller 2060*a* at its end which is adapted to enter the slot in portion 2152*b* when valve 2060 is projected. Roller 2060*a* then engages the cam formed by the bottom of slot 2152*d*.

The spring in handle 2153 holds shaft 2154 and member 2156 in the position shown. When handle 2153 is pulled upon, spring 2158 will move member 2156 longitudinally and rotate disk 2162 and shaft 2163.

A shaft 2166 is provided having a crank handle 2167 at one end. (See FIG. 25.) Crank 2167 has a detent 2167*a* at its bottom adapted to enter a recess in an arm 2169 swingable about the axis of a pin or shaft 2170 at one end thereof and urged by a coiled spring 2171 in a direction to move arm 2169 away from detent 2167*a*. Arm 2169 has a lateral projection 2169*a* positioned to ride on the curved surface on the projection at the top of arm 2152. Shaft 2166 has an arm 2166*a* at the end opposite crank 2167, which arm is arranged to engage a roller 2174 carried on an arm 2034*a* secured to lower latch 2034. Arm 2166*a* is also adapted to engage a roller 2175 carried on an arm 2035*a* secured to the hoist latch 2035.

Arm 2152 is swung to positions to place the hoist in condition for power or manual operation. With the parts in the position shown in FIG. 25, the hoist is in condition for power operation. Arm 2152 cannot now be swung to manual position to bring worm 2107 into engagement with worm gear 2106 because this movement will be stopped by the roller at the end of valve 2060 engaging the end of the slot in portion 2152*b*. Crank handle 2167 cannot be rotated because it is locked in position by detent 2167*a*. It may be stated that when released, crank 2167 can be rotated to release "lower" latch 2035 by engaging arm 2166*a* with roller 2174. This would be done to manually lower the hoist. Crank 2167 can also be rotated to release the "hoist" latch 2034 by engaging arm 2166*a* with roller 2175. This would be done when it was desired to manually operate the hoist. When the hoist is to be placed in condition for manual operation, valve 2060 is moved away from portion 2152*b*. Arm 2152 can then be oscillated by pulling on handle 2153 and then swinging said arm about the axis of shaft 2025. The projection 2169*a* of arm 2169 will seat in the recess 2152*a*, and arm 2152 is locked in position for manual operation. Detent 2167*a* is then released and crank 2167 can be rotated and worm 2017 is moved into engagement with worm gear 2016. The hoist can then be manually operated by rotation of crank handle 2020.

In the hydraulic schematic a somewhat different construction is shown at the top of member 2152 which accomplishes the same functions. Handle 2153 is shown as comprising a cylindrical sleeve 2153*a* secured to arm 2152. (See FIG. 27.) A handle portion 2153*b* in the form of a cylindrical shell is slidable on portion 2153*a* and has a stem 2153*c* extending axially thereof and projecting beyond sleeve 2153*a* and arm 2152. Stem 2153*c* has a shoulder thereon which engages a compression coiled spring 2153*d* surrounding stem 2153*c* and disposed within sleeve 2153*a*. Stem 2153*c* is projected outwardly by spring 2153*d* into engagement with the actuating plunger of a switch ID2A. Slot 2152*a* is shown in member 2152*b* adapted to receive arm 2152. Member 2152*b* in FIG. 27 has one side formed as a cam adapted to be engaged by roller 2060*a*.

When handle portion 2153*b* is moved longitudinally to move member 2152 out of slot 2152*a*, stem 2153*c* will be moved away from switch ID2A and said switch will be opened. Portion 2152*b* is shown as directly blocked by

the roller at the end of valve 2060. Shaft 2166 is shown as having a portion 2166a receivable in a slot in arm 2152 so that crank 2167 cannot be operated. The latches 2034 and 2035 thus cannot be moved by crank handle 2167 when the hoist is set for power operation. Shaft 2166 is provided with cams 2166a and 2166b adapted to respectively engage projections of the latches 2034 and 2035 when shaft 2166 is oscillated in manual operation. The construction shown in the mechanical schematic FIG. 25 is used in actual practice. It will be noted that when handle 2153, as shown in FIG. 25, is moved longitudinally of shaft 2154, that member 2156 will be moved away from the actuating plunger of switch ID2A. When handle 2153 is released and moved to its position by spring 2158 switch ID2A will be actuated.

Automatic hoist control

A valve casing 2038 is provided having a valve chamber 2038a therein in which is movable a valve 2039. A compression coiled spring 2037 urges valve 2039 upwardly, as shown in FIG. 26. A passage and conduit 2040 extends from an intermediate part of chamber 2038a and is connected to a conduit 2041 which will contain liquid under accumulator pressure, as from the accumulator 2042. Such liquid will hereinafter be referred to as PA. Conduit 2041 extends to a valve chamber 2043a (see FIG. 27), in a valve casing 2043 in which is movable a valve 2045. Valve 2045 is urged downwardly by a compression coiled spring 2044. Valve 2045 is a pressure reducing valve. PA can pass around the lower portion of valve 2045, as shown in FIG. 27, due to the annular groove 2043b, and said liquid then passes to a conduit 2046 which communicates with a valve chamber 2047a in a valve casing 2047 and in which is movable a valve 2048. Valve 2048 is urged upwardly, as shown in FIG. 27, by a spring 2049. With the valve 2048 in the position shown in FIG. 27, said PA can pass around said valve between the lands thereof to a conduit 2050 which extends to the brake casing 2002a and into a chamber 2002g therein. Members 2002d are partially disposed in chambers 2002g and have peripheral flanges fitting in portions of chambers 2002g so that the liquid from conduit 2050 will force the plungers 2002d away from disks 2002b and 2002c, thus compressing the springs 2002e and releasing the brake 2002. Whenever the hoist is in condition for power operation, the brake is thus hydraulically released.

A passage and conduit 2051, see FIG. 26, extends from chamber 2038a to an intermediate point in a valve chamber 2052a in a valve casing 2052, in which chamber is movable a valve 2053. A passage and conduit 2054 extends between valve chambers 2038a and 2052a and is in communication with conduit 2040 through an annular groove 2038b in valve casing 2038a extending around valve 2039. Passage 2051 has communicating therewith a conduit 2056 which extends to the inlet side of motor 2015. Conduit 2056 also extends from conduit 2051 to an intermediate point in the valve chamber 2058a in a valve casing 2058 in which is movable a valve 2060. A compression coiled spring 2059 urges valve 2060 in a direction to move one end of said valve outwardly from chamber 2058. A passage 2089 extends from valve chamber 2038a to an intermediate point in valve chamber 2086a and then to tank through conduit 2108. Valve 2053 projects from casing 2052 and has secured to its end a cam roller 2061 adapted to be moved by cam 2030E. A passage and conduit 2062 extends from valve chamber 2052a to a valve chamber 2063a in a valve casing 2063 in which a movable a valve 2064. Valve 2064 projects from valve casing 2063 and carries at its end a cam roller 2065 disposed to be operated by cam 2030D. Valve 2064 is urged upwardly, as shown in FIG. 26, by a compression coiled spring 2073. A conduit 2066 communicates with conduit and passage 2062 and extends to the discharge side of hydraulic motor 2015. A passage and conduit 2067 extends from one end of chamber 2052a to an intermediate point in valve chamber 2063a. A passage and conduit 2068 extends from adjacent one end of valve chamber 2063a to a valve chamber 2070a in a valve casing 2070 in which is movable a valve 2071. Valve 2071 is urged toward the lower end of chamber 2070a, as shown in FIG. 26, by a compression coiled spring 2072. A passage and conduit 2074 extends from conduit 2068 to the lower portion of valve chamber 2063a. A passage and conduit 2075 extends between valve chambers 2063a and 2070a adjacent the lower end of the latter, as shown in FIG. 26. Valve casing 2070 has therein a passage 2070b extending from passage 2068 to the upper portion of valve chamber 2070 above valve 2071. A passage and conduit 2076 extends from valve chamber 2070a to tank. A conduit 2078 communicates with conduit 2066 and extends to an intermediate point in valve chamber 2058a. A passage 2079 connects conduits 2056 and 2078 and has therein a small orifice. A conduit 2082 extends from the low pressure side of valve chamber 2043a to valve chamber 2058a. The low pressure side of valve 2045 delivers pressure at substantially 200 pounds per square inch. Liquid under this pressure of 200 pounds will hereinafter be referred to as PC. Conduit 2082 extends from the lower end of valve chamber 2043, as shown in FIG. 27, and a conduit and passage 2083 extends from conduit 2082 to an intermediate point in valve chamber 2043a. A conduit 2084 communicates with conduit 2082 and extends about a valve casing 2085 and to an intermediate point in a valve chamber 2086a in a valve casing 2086 in which is movable a valve 2088. Valve 2088 projects from one end of casing 2086 and carries a cam roller 2090 positioned to be engaged by a cam 2030c.

A conduit 2089 extends from the lower portion of valve chamber 2038a to an intermediate point in valve casing 2086a. A conduit 2093 extends from valve chamber 2085a at a point adjacent conduit 2091 and through an orifice 2094 and thence to the upper portion of valve chamber 2052a. A conduit 2096 communicates with conduit 2093 and extends to valve chamber 2086a. A passage and conduit 2098 extends from valve chamber 2086a to tank. Valve 2088 has an extension at one end connected to a crank disk 2100 carried on a shaft 2101 having secured thereto a lever arm 2103 pivotally connected by a link 2104 to the operating plunger of a pull-type solenoid SC1. Shaft 2101 also carries an arm 2105 adapted to engage the actuating plunger of an electrical switch IC101A. Switch IC101A operates a lamp which indicates energization of solenoid SC1. A passage and conduit 2108 leads from the upper portion of valve chamber 2086a to tank, as shown in FIG. 27.

Valve 2048 has a projection connected to a crank disk 2110 carried on a shaft 2111 to which is secured an arm 2112 connected to the operating plunger of a push-type solenoid SC2. An arm 2118 is secured to shaft 2111 and is disposed to engage the actuating plungers of electrical switches IC102A and IC102B. Switch IC102A operates a lamp which indicates that solenoid SC2 is energized. Switch IC102B is used to operate a holding circuit for solenoid SC2. A conduit and passage 2115 leads from adjacent the upper end of valve chamber 2047a to tank, and a conduit and passage 2116 leads from adjacent the bottom of said valve chamber to tank. A valve 2120 is movable in valve chamber 2085a, the same projecting from one end of said valve casing 2085 and being pivotally connected to latch 2035. A compression coiled spring 2121, as shown in FIG. 27 urges valve 2120 downwardly. Valve 2120 is operatively connected to a switch ID4ABC, and as shown in FIG. 27, a bell crank lever 2122 is pivoted to the top of valve casing 2085, one arm of which is engaged by the top of valve 2120. The other arm of lever 2122 is connected by a link 2123 to an arm 2124 secured to a shaft 2125. An arm 2126 on shaft 2125 engages the actuating plungers of the switch ID4ABC. Switch ID4ABC indicates that latch 2035 is in engaged position.

A conduit 2130 extends from an intermediate point in valve chamber 2058a, see FIG. 27, to an intermediate point in a valve chamber 2132a in a valve casing 2132 in which is movable a valve 2134. A passage and conduit 2135 extends from an intermediate point in casing 2132a, around valve casing 2085, to an intermediate point in valve chamber 2063a and the same passes around valve 2064 and continues to the top of valve chamber 2038a. A passage 2157 extends from valve chamber 2085a to tank. A passage 2140 extends from the upper part of valve chamber 2132a to tank and another passage 2141 extends from the lower portion of said valve chamber to tank.

A passage and conduit 2143 extends from the lower portion of valve chamber 2132a and communicates with conduit 2093 already described. Valve 2134 projects below valve casing 2132 and is pivotally connected at its lower end to latch pawl 2034. Valve 2134 engages at its upper end one arm of a bell crank lever 2145, the other arm of which is pivotally connected to a link 2146 in turn connected to an arm 2147 secured to a shaft 2148, which shaft carries an arm 2149 adapted to engage the actuating plungers of a switch ID3ABCDE. Switch ID3ABCDE indicates the position of latch 2034. Valve 2134 is normally urged downwardly by a spring 2117 disposed thereabove in chamber 2132a.

Cams 2030F and 2030G are arranged to respectively actuate switches IC5 and a spare. Switch IC5 is operated when the hoist accelerates and prevents operation of relay RC1 (later described) to prevent operation of brake 2002 when the hoist is accelerating. In the hydraulic schematic FIG. 26, said cams act directly on switches IC5 and the spare. In the mechanical schematic FIG. 25, said cams 2030F and 2030G respectively actuate plungers 2080 and 2081, movable in stationary casings 2080a and 2081a respectively. Said plungers carry rollers at their lower ends arranged to engage said cams. Plungers 2080 and 2081 are urged downwardly by springs 2087 and 2087a respectively which at their lower ends engage said plungers and at their upper ends engage flanges in casings 2080a and 2081a respectively. Plungers 2080 and 2081 are prevented from rotating by pins secured thereto adjacent their bottoms and extending into elongated slots in casings 2080a and 2081a. Said plungers are provided with cylindrical upper portions having helical slots in their walls in which are disposed pins 2092 and 2095 respectively carried in shafts 2092a and 2095a disposed in the upper ends of and revoluble in the upper ends of plungers 2080 and 2081 respectively. Shafts 2092a and 2095a have secured to their upper ends arms 2092b and 2095b arranged to engage switches IC5 and the spare. Springs 2087 and 2087a maintain the rollers at the ends of plungers 2080 and 2081 in engagement with cams 2030F and 2030G respectively. When said plungers are raised by said cams, shafts 2092a and 2095a are oscillated by the helical slots in said plungers and the pins 2092 and 2095 therein and arms 2092b and 2095b are oscillated and actuate switches IC5 and the spare. Cam 2030H engages a roller 2178 carried at one end of a rack 2180 which meshes with a pinion 2181. Pinion 2181 is secured to the shaft of a linear potentiometer 2182.

A shaft 2184 is driven from shaft 2014 through beveled gears 2185 and said shaft 2184 drives a tachometer generator 2186.

As previously described, the round of ammunition is placed in the loader by the operator and is moved in position to be engaged and elevated by the lower hoist. The lower hoist elevates the round and moves the same into the carrier. (See FIG. 31.) As described, there are two loaders and there are thus two lower hoist casings and these deliver to the carrier at points 180 degrees apart. These two hoists are separately controlled.

Operation of a hoist cycle

To initiate a power hoist cycle the operator will swing lever 2152 by its handle 2153 to the position shown in FIG. 27. Referring to the hydraulic schematic FIG. 26, it will be seen that PA can pass from the accumulator 2042, through conduit 2041 to the valve chamber 2043a in which valve 2045 is movable. (See FIG. 27). Valve 2045 as previously stated is a pressure reducing valve and the same reduces the PA from 1500 pounds per square inch to substantially 200 pounds per square inch (PC). Spring 2044 is set to balance a pressure of 200 pounds. As shown in FIG. 27 the PA from accumulator 2042 is blocked by the lower land of valve 2045. If fluid is called for there will be a pressure drop in chamber 2043a below said valve. Spring 2044 will move valve 2045 downward. PA will now enter chamber 2043a and flow out through conduit 2083. Should the pressure rise above 200 pounds, valve 2045 will be moved upward against the pressure of spring 2044 shutting off PA. The pressure through conduit 2083 is thus held to 200 pounds. PA can pass around valve 2045 in the groove 2043b and then through conduit and passage 2046, around valve 2048 between the lands thereof and then through conduit and passage 2050 to chamber 2002g in the brake 2002. During stand-by solenoid SC2 is continually energized and this moves valve 2048 down to the position shown in FIG. 27. This PA forces the plungers 2002d away from the disks in the brake against the pressure of springs 2002e so that the brake is released. The hoist is thus released and ready for power operation. When the ammunition is properly in the magazine and the hoist cycle is to be initiated, switches IA5ABCD, IA1ABCD, IA9B, IA8B, IF1A, IF2A, ID3ABCDE and ID2A will be actuated. Switch IA5ABCD indicates that there is a projectile in hoisting position in the magazine and lower hoist tube. Switch IA1ABCD indicates that there is a powder case in hoisting poistion in the magazine and lower hoist tube. Switch IA9B indicates that clutch members 121 and 122 (FIG. 9) are engaged and that the projectile drum cannot be indexed. Switch IA8B (not shown) indicates that the powder drum is locked against indexing by engagement of clutches similar to clutch members 121 and 122. Switch IF1A indicates that the carrier is latched to the lower hoist in position to receive a round of ammunition. Switch IF2A indicates that there is no round in the carrier chamber. Switch IA6A indicates the position of rack 48. (FIG. 9). Switch IA11A also indicates position of rack 48. Switch ID3ABCDE indicates that the hoist latch 2034 is in proper position for a hoist cycle. Switch ID2A indicates that the hoist is set for a power operation. When said switches have been operated, an electrical circuit is closed and solenoid SC1 will be energized. This will pull upwardly on link 2104 and arms 210s, as shown in FIGS. 25 and 27, which will oscillate shaft 2101 and through disk 2100 move valve 2088 downwardly from the position shown in FIG. 25. This will move roller 2090 into position to be engaged by cam 2030C. Movement of shaft 2101 swings arm 2105 to operate switch IC101A. PC can now pass from valve chamber 2043c, through conduits 2083 and 2082, to valve chamber 2058a. Valve 2060 will be moved to project its end from valve casing 2058 and the roller at the end of said valve will engage portion 2152b of arm 2152, as shown in FIG. 27, or move said roller into portion 2152b, as shown in FIG. 25, thus blocking any movement of arm 2152 to place the hoist in condition for manual operation. PC can also pass from conduit 2082 through conduit 2084 around valve casing 2085 to valve chamber 2086a. Since valve 2088 has been moved downwardly as described, PC can now pass around said valve between the lands thereof to conduit 2091 and to valve casing 2085a below valve 2120. Valve 2120 is moved upward and this swings "hoist" latch 2035 away from the latch cam 2033, thus releasing the hoist for a hoisting movement. When valve 2120 is moved upward, PC can then pass in chamber 2085a to conduit 2093 and through the orifice 2094 to valve chamber 2052a at the top of valve 2053. Valve 2053 is moved downward-

ly and its roller 2061 is moved down for engagement with cam 2030E. Valve 2053 is moved downward at a controlled rate of speed due to orifice 2094. When valve 2053 moves down, PA is ported through conduit 2040, through groove 2038*b* to conduit 2054, around valve 2053 to conduit 2051, and conduit 2056 to the B-end or motor 2015, thus starting movement of the hoist through shaft 2014, gears 2002 and shaft 2001, and driving hoist sprocket 2000.

The hoist has a chain flight cycle of 97.5 inches. A change gear arrangement allows manipulation for a flight of 112.5 inches. Downward movement of valve 2088 ports pressure to the bottom of valve 2039. This passes from conduit 2084, around valve casing 2085 and around valve 2088 to conduit 2089 and to the lower portion of valve chamber 2038*a*. Valve 2039 is held in the position shown in FIG. 26 by said pressure and by spring 2037. The liquid for actuating motor 2015 must pass through the port 2052*b* from valve casing 2052*a* to the conduit 2054 and the motor is started and its acceleration controlled by valve 2053 as it moves downwardly at a controlled rate of speed as above described, and gradually opens port 2052*b*. The acceleration of motor 2015 is thus controlled by valve 2053. After two to six inches of movement of the hoist chain, solenoid SC1 is de-energized and after 27 inches of chain travel, cam 2030C moves also 2088 back to its initial position ready for the next cycle. It will be noted that valve 2088 is a detent valve and will be held in the position to which it was moved by the energization of solenoid SC1 by the detents 2087, after said solenoid is de-energized, until it is moved by cam 2030C. When valve 2088 is thus moved back to the position shown in FIGS. 25 and 27, it cuts off PC to valve 2053, through conduit 2093, and also "shuts" off PC to valve 2039 through conduit 2089. This cuts off PC to valve 2039 through conduit 2089, and valve 2039 moves down thus porting PA to the B-end or motor 2015 bypassing valve 2053 and permitting valve 2053 to be moved back to the position shown in FIGS. 25 and 26 ready for next cycle. At 33 inches of chain travel, cam 2030E starts to move valve 2053 upward and at 48 inches of travel said valve is in its position for a new cycle. The upward movement of valve 2088 by cam 2030C cuts off pressure from valve 2120 through conduit 2091 so that latch 2034 is not held by pressure. Cam 2030B holds latch 2035 up or released for six revolutions of shaft 2014, and on seventh revolution, cam 2030B allows said latch to ride on latch cam 2033 ready to engage the shoulder on said cam to stop the hoist. When cam 2030B allows latch 2035 to engage latch cam 2033, eleven inches of hoist travel remain. It may be noted that valve 2120 will be moved upward by action of crank 2167 during manual hoist operation but no function is involved. Cam 2030A will likewise hold latch 2034 away from latch cam 2032 for six revolutions of shaft 2014 and will then let latch 2034 engage cam 2032 ready to snap into stop position.

The discharge from motor 2015 passes through conduit 2066 to conduit 2062, around valve 2053 (now down), to conduit 2067, around valve 2064 between the upper lands thereof, through port 2063*b* to conduit 2068, around valve 2071 between the lands thereof and to tank through conduit 2076. Valve 2053 controls the acceleration of the motor 2015 until shaft 2014 attains full speed, at which time valve 2064 takes full speed control. At 33 inches of chain travel cam 2030E starts to move valve 2053 upwardly and at 48 inches of chain travel said valve is in its uppermost position. After 3.5 inches of chain travel, valve 2064 is moved downward. The downward movement of valve 2064 takes place as follows. After three and one-half inches of hoist travel, cam 2030A moves valve 2134 upwardly a sufficient distance to move the upper land thereof above port 2132*b* and PC can then pass from valve 2045, through conduit 2082, to and through valve chamber 2058*a* to conduit 2130, through valve chamber 2132*a* to conduit 2135, around valve casing 2085 to the top of valve 2064 in valve chamber 2063*a*. Valve 2064 is thus moved downwardly. After said 3.5 inches of chain travel, cam 2030D is in position to permit downward movement of valve 2064. After 17 inches of chain travel, valve 2064 is at the limit of its downward movement. When valve 2064 is moved downwardly the discharge from motor 2015 through port 2063*b* and conduit 2068 is gradually cut off. The discharge from the motor now passes from conduit 2066 to conduit 2062, around valve 2064, between the lower lands thereof, through the port 2063*c* from chamber 2063*a* to conduit 2074, thence to conduit 2068 and around valve 2071 to the tank conduit 2076. The discharge is thus now controlled by valve 2064 through the port 2063*c* leading to conduit 2074 and roller 2065 is moved downward in position to be engaged by cam 2030D. After 62 inches of hoist travel, cam 2030D moves valve 2064 back upward to the position shown in FIGS. 25 and 26, thereby decelerating shaft 2001 by closing port 2063C. The discharge from motor 2015 now must pass from conduit 2066, around valve 2053 to conduit 2062 to chamber 2063*a* to conduit 2068 to chamber 2070*a* to tank through conduit 2070. Valve 2064 will decelerate the hoist to a speed of two and five tenths inches per second after which latch 2035 engages latch cam 2033 and the hoist is stopped.

The potentiometer 2182 and tachometer generator 2186 are provided in order to brake and stop the hoist in the event that it was not for some reason decelerated as above described. As shown in the schematic circuit, FIG. 28, the potentiometer 2182 controls a resistance 2182*a*. The generator 2186 is driven at a speed commensurate with hoist speed as it is driven through the beveled gears 2185 from shaft 2104. If the hoist is decelerated as intended, the speed of the generator 2186 will be low. Should for some reason the hoist continue at full speed, generator 2186 would be rotating at high speed and would generate a current of higher voltage. The potentiometer is moved by the rack 2180 through pinion 2182 and rack 2180 is driven by the cam 2030H. The resistance 2182*a* is governed by the position of potentiometer 2182 determined by cam 2030H and so is controlled according to hoist position. With the increased voltage from generator 2186, current will be forced through the resistance 2182*a* and sufficient current will be produced in the line 2182*b* to actuate solenoid RC1. Solenoid RC1 controls a contact RC1*a* which is opened when solenoid RC1 is energized. This opens a circuit through line RC1*b* and de-energizes solenoid SC2. Spring 2049 can now move valve 2048 upwardly, as shown in FIG. 27, and this will cut off PA from valve chamber 2047A. Pressure is thus cut off from the brake chamber 2002*f* allowing springs 2004 to engage the disks 2000*b* and 2000*c* and set the brake. The hoist will thus be braked and stopped so that no damage will be done.

Manual Operation

To perform a manual operation of the hoist the accumulator 2042 must be relieved of pressure. The accumulator has a dump valve which is operated to relieve the said pressure. This unlocks lever 2152. Handle 2153 is pulled out and this operates switch ID2A. Lever 2152 can now be swung counter-clockwise, as shown in FIGS. 25 and 27, to the position for manual operation. The cam on member 2152*b* acts on roller 2060*a* to move it and valve 2060 to the left, as shown in FIGS. 25 and 27. The fluid from motor 2015 in conduit 2056 and in conduits 2066 and 2078 can now be by-passed around valve 2060. At this time projection 2169*a* will drop into the notch 2152*a* and crank 2167 will be released for rotation. When lever 2152 is swung, shaft 2025 is oscillated and link 2009 will be moved through arm 2024, link 2023

and bell crank lever 2021. Movement of link 2009 through lever 2007 and link 2006 swings yoke 2005, thus pulling on plungers 2002*f* and compressing springs 2002*e* to relieve pressure on the disks 2002*c* and 2002*b*. The brake is now released and the hoist can be moved. Swinging of lever 2152 also operates link 2027 through arm 2026 and worm 2017 is moved into engagement with wormwheel gear 2016. The operator can release either of the latches 2034 and 2035 by movement of crank handle 2167, which as stated, has been released. The hoist can now be lowered by rotation of crank handle 2020. It is only necessary to hold release crank 2167 for two revolutions of hand crank 2020 after which the latches 2034 and 2035 will ride on the contour of latch cams 2032 and 2033. At 350 revolutions of crank 2020 the contours of cams 2030A and 2030B will allow engagement of latches 2034 and 2035 with cams 2032 and 2033 respectively, which positively brings the movement of the hoist to a stop at the end of the 97.5 inches chain flight cycle.

The above procedure (except release of crank handle 2167) is to be followed if an emergency stop occurs.

THE CARRIER AND COOPERATING PARTS OF THE UPPER HOIST

Disposed immediately above the lower hoist is a carrier 300, which cooperates with an upper hoist. Depending from the base ring of the gun mount proper and rotating therewith is a central column 302. Said upper hoist comprises casings or tubes 301 which are disposed at opposite sides of said column 302, the same being secured to said column by brackets 303 shown as integral therewith. The carrier comprises a cylindrical supporting portion 306 which surrounds said central column 302 and is mounted on vertically spaced ball bearings 307 disposed between portions 306 and said column. Member 306 has an annular flange 306*a* extending outwardly therefrom at its upper portion, the same having an outer step or surface to which is secured by the headed and nutted bolts 312, an internal gear 310. A pinion 314 meshes with gear 310 and is carried on the driving shaft of a hydraulic motor 600 supported on said central column. A ring 316 of general cup-like form has an outer peripheral flange 316*a* which is supported upon the main deck 318 and the supporting structure 320 thereof. Ring 316 has a central portion 316*b* through which extends a portion 306*b*, constituting a well for containing electrical cables used with the operating mechanism for the carrier. Ring 316 has openings at either side thereof through which respectively extend the upper ends of the tubes 1900*a* of the lower hoist. Portion 306*b* has a plate at its top portion secured to a bottom plate 300*bl* of a spider 300*b*. Spider 300*b* has radially extending arms at its bottom and circumferentially spaced upper portions 300*c* between which extend the plate-like ribs 300*d* disposed in vertical radial planes. The spider 300*b* has at opposite sides thereof bosses 300*g* having finished top surfaces to which are secured the vertically extending brackets 324. These brackets have vertically extending channels therein substantially semi-cylindrical in horizontal cross section with their open sides facing outwardly. Supported by brackets 324 and above the same are members 326 adapted to receive units of ammunition. Members 326 are generally in the form of semi-cylindrical casings. As shown in the schematic FIGS. 29 and 30, the upper ends of the lower hoist are disposed adjacent members 324. The members 326 have vertically extending passages therethrough, the central axes of which align with the central axes of the channels in members 324 and are substantially coaxial with the tubes of the lower hoist through which the round of ammunition moves vertically. The members 326 have upper and lower horizontal top and bottom plates or portions having suitable bosses bored to receive vertically extending shafts 328 at each side of said members, said shafts being journaled in said bosses. Shafts 328 have secured thereto a number of vertically spaced ejection members 330. As shown in FIGS. 32 to 38, members 330 are disposed at opposite sides of members 326 and have arcuate inner surface defining a channel in members 326 and extending partially about the units or rounds of ammunition P at opposite sides of said units or rounds. The round of ammunition including the powder case and the projectile supported thereon is delivered upwardly by the lower hoist into the members 326 and between the members 330.

The carrier has a ring or annular flange 300*i* extending thereabout somewhat adjacent its upper end which surrounds members 326 and also the upper hoist. The portions 300*c* of the spider 300*b* have brackets 332 secured thereto and braces 333 are secured to said brackets and extend upwardly to and are secured to the flange 300*i*. There are a pair of the braces 333 at each side of the carrier. Other braces 334 are secured to brackets 332 at their lower ends and extend outwardly and upwardly to flanged brackets 335 which are secured to the outer sides of members 326. There are a pair of the braces 334 at each side of the carrier.

As the round of ammunition is pushed upwardly into the members 326 by the lower hoist, the nose of the projectile engages the sides of a yoke 337 which is secured to a cable 338. As most easily seen in schematic FIG. 31 and also as shown in FIGS. 29 and 30, cable 338 runs under a sheave 340 adjacent the bottom of member 326 and then extends upwardly to a double sheave 342 over which it passes and extends downwardly to a stationary bracket 343 on the carrier to which it is secured. The cable 338 at the upper side of yoke 337 extends upwardly over a sheave 345 and downwardly over another portion of double sheave 342, the same then being attached to a bracket 346 secured to the upper portion of member 326. As shown in FIGS. 30 and 36, the sheaves 340 and 345 are in planes at right angles to the sheave 342 but they are brought into one plane in schematic FIG. 31 for a simplified showing. As yoke 337 is moved upwardly by the projectile, cable 338 is progressed and sheave 342 will be moved downwardly.

A yoke 348 is secured to the supporting shaft of sheave 342, the same having secured thereto a piston 350. Piston 350 moves vertically in a chamber 352*a* of a block 352 supported on member 326 and which will contain fluid, such as oil. When piston 350 is moved downwardly with sheave 342, the oil in chamber 352*a* will be forced through a small passage 352*b* at the bottom and at one side of chamber 352*a* and into a chamber 352*c* and at one side of a piston 353 therein. A compression coiled spring 354 is disposed at one side of piston 353 and will resist movement of said piston. When piston 350 moves downward, oil from chamber 352*a* will aso be forced through a passage 352*d* against a piston 355 in a chamber 352*e*, which piston has at one side thereof a compression coiled spring 356 which will resist movement of piston 355. A passage 352*f* leads from chamber 352*e* upwardly to a chamber 352*g* in which is disposed a piston 358. A passage 352*h* also leads from chamber 352*c* to chamber 352*g*. Air under pressure will be supplied to chamber 352*g* above piston 358. It will thus be seen as the projectile is moved upwardly in member 326 and piston 350 is moved downwardly, that piston 350, yoke 337 and thus the projectile and round of ammunition will be decelerated in their movement by the resistance offered to the fluid forced out of passage 352*a* by the various pistons 353, 355 and 358, and the springs 354, 356 and the air in chamber 352*g*. The round of ammunition is thus properly decelerated so that its momentum will not move it vertically off of its support in the lower hoist and it comes to rest in member 326 in the desired position, as shown in dotted lines in FIG. 31. The lower hoist is also decelerated as it completes its upward movement.

As the projectile is moved upward in member **326**, it engages a roller **360** carried on a lever **361** oscillatable on a pivot **362** in member **326**. Lever **361** has a portion connected by a rod **363** to a switch IF2 at the lower end of member **326**. As the projectile moves upwardly, rod **363** will be moved downwardy and switch IF2 will be operated. Rod **363** will be moved upwardly when there is no projectile in member **326** by a spring **365** engaging a bracket **326***a* secured to member **326** and engaging a collar **366** on rod **363**. Such upward movement of rod **363** will also operate switch IF2. Arm **361** has a second arm **368** secured thereto and swingable about pivot **362**, the same normally being held in position by a pin **369** extending therethrough and into arm **361**. (See FIG. 37.) Arm **368** has secured thereto a rod **370** which extends upwardly and is connected to a switch IF10 at the upper side of member **326**. Switch IF10 will be closed as the projectile swings ever **361** and will be opened when spring **365** moves rod **363** upwardly and swings lever **361** clockwise with no projectile in the carrier. Switches IF2 and IF10 indicate that there is a projectile and round of ammunition in member **326**, and also that there is no projectile or round of ammunition in member **326**. Said switches also cooperate to prevent an operation to transfer the round from member **326** into the upper hoist until there is a projectile in member **326** of the carrier and to prevent supplying a round to member **326** when there is already a round therein. Should one of the members **326** be rendered inoperative for any reason, as in action, arm **368** can be moved from the position shown and held in another position to operate switch IF10 to give a false indication or signal that a projectile is in the carrier. The other carrier or member **326** can then operate as usual.

The carrier **300** is rotated to bring the round-receiving members **326** into axial alignment with the lower hoist tubes respectively for receiving the round of ammunition and the carrier is then rotated to bring members **326** into transverse or radial alignment with the upper hoist tubes respectively so that the round of ammunition can be transferred from members **326** to the hoist tubes **301** of the upper hoist. When the carrier is aligned with the lower hoist it is latched in this position.

Carrier, lower hoist latch

For latching the carrier to said lower hoist a portion of a flange **300***a* at the lower end of spider **300***b* is provided with a recess **300***j*. (See FIG. 40.) A latch is provided comprising a roller **380** rotatably mounted in the long arm of a bell crank lever **381** oscillatable on a pivot **382** mounted on member **316**. The short arm of lever **381** has pivotally connected thereto one of a pair of toggle links **383**, the other of which has its outer end pivoted to a bracket **384** carried on the lower hoist. Links **383** are connected by the pivot **386** which is disposed in a slot **387***a* of an actuating link **387** which is pivoted at one end to a plunger rod **388** connected to a valve **660** movable in a valve chamber **390***a* formed in a valve block **390**. A spring **385** engages bracket **384** and also a collar on a rod **391**, which rod is pivotally connected to lever **381** and tends to push the long arm of said lever and roller **380** upwardly. A projecting end of lever **381** is positioned to operate a switch IF1 when roller **380** enters notch **300***j*. Switch IF1 when thus operated will indicate that the carrier is latched to the lower hoist and in position to receive a round from the lower hoist.

As shown in FIG. 40, plunger **388** is connected to a piston **660** movable in a chamber **390***a* of valve block **390**. Said block has another chamber **390***b* in which is movable a valve **662** having a valve rod pivotally connected to one end of a link **663**, the other end of which is pivotally connected to a lever **664** swingingly mounted about a fixed pivot **665**. Lever **664** has pivotally connected thereto at opposite sides of pivot **665** the actuating plungers of cores of push type solenoids SF9 and SF8 respectively. Lever **664** has portions thereon positioned to engage the actuating plungers of electrical switches IF108 and IF109 respectively. Lever **664** will be held in either of its two positions by a spring-pressed detent **672** engaging recesses in end portion **664***a* of said lever. A conduit and passage **390***c* extends from an accumulator having liquid under pressure into chamber **390***a* and to chamber **390***b*. A passage **390***d* extends from the bottom of chamber **390***a* to an intermediate point in chamber **390***b*. A passage **390***e* extends from the top of chamber **390***b* to the bottom thereof. A passage and conduit **390***f* extends from an intermediate point in chamber **390***b* to tank and communicates with passage **390***e*.

Carrier, upper hoist latch

Member **306** has an upper flange **300***hl* which also has a recess **300***k* in a top annular portion thereof adapted to receive a latching roller **450**. Roller **450** is journaled in the long arm of a bell crank lever **451** which is oscillatable on a pivot **452** mounted in a portion of the upper hoist. The short arm of bell crank lever **451** is pivotally connected at its end to one end of a pair of toggle links **453**, the other end of which is pivotally connected at its outer end to a bracket **454** also carried on the upper hoist. Links **453** are pivotally connected by a pivot **455** which extends through a slot **457***a* of an actuating link **457** connected to a plunger rod **458** which will be connected to a valve **680** in a valve block **460**. The long arm of lever **451** has pivotally connected thereto adjacent roller **450** a rod **456** guided in bracket **454**. Rod **456** carries a collar against which presses one end of a compression coiled spring **459**, the other end of which bears against bracket **454** carrier on the upper hoist. Spring **459** will force roller **450** toward the carrier ring when toggle comprising links **453** is broken. Lever **451** has a projection adapted to operate a switch IF20 when roller **450** seats in notch **300***k*. Switch IF20 will then indicate that the carrier is latched to the upper hoist and in position to transfer a round of ammunition to said upper hoist. Plunger rod **458** is connected to a valve **680** movable in a chamber **460***a* of valve block **460**. Block **460** has another chamber **460***b* in which is movable a valve **681** having a rod pivotally connected to one end of a link **682** which is pivotally connected at its other end to a lever **683** swingable about a fixed pivot **684**. Lever **683** is pivotally connected at opposite sides of the pivot **684** to the operating plungers or cores of push type solenoids SF6 and SF7 respectively. Lever **683** is adapted to alternately engage the actuating plungers of switches IF106 and IF107. Lever **683** will be held in either of its two positions by a spring-pressed detent **687** adapted to enter recesses in one end thereof. A passage and conduit **460***c* extends from an accumulator having liquid under pressure to the lower end of chamber **460***a* and continues to an intermediate point in chamber **460***b*. A passage **460***d* extends from the top of chamber **460***a* to an intermediate point in chamber **460***b*. A passage **460***e* extends from the top of chamber **460***b* to the bottom thereof and a passage and conduit **460***f* extends from an intermediate point in chamber **460***b* to tank, the same communicating with passage **460***e*.

As stated, the upper hoist which comprises the tubes **301** at opposite sides thereof rotates with the gun and with said central column **302** which is secured to and depends from the base ring of the mount proper, as shown in FIGS. 29 and 31.

Round transferring means of carrier

Shafts **328** which carry the ejector members **330** have connected thereto respectively arms **392**. The arms **392** have respectively connected thereto links **393** in turn connected to levers **394**, the other ends of which are secured respectively to shafts **395**. Shafts **395** are journaled in the end plates of members **326**. Meshing gears **396** are respectively secured to the shafts **395**. The levers **394** are connected intermediate their ends to one end of links **398**, the other ends of which are respectively

connected to one of the arms of bell crank levers **400** which are mounted for oscillation on pivots **397** respectively secured in the end portions of members **326**. The other ends of bell crank levers **400** are respectively connected to links **401** which have connected to their other ends guide rods **402** respectively which move in passages in the bosses **403** secured to said end portions of members **326**.

Round transferring means of upper hoist and carrier

The upper hoist has a member or shutter **406** secured to a shaft **407** suitably journaled in bearings in portions **301***b* adjacent the top and bottom of the hoist casing. (See FIGS. 38, 33 and 34.) Member **406** extends quite a distance in tube **301** and is somewhat longer than the round of ammunition. Shaft **407** has secured thereto an arm **408** to the end of which is pivotally secured a link **409**. The other end of link **409** is pivotally connected to a lever **410**, the other end of which is pivotally connected to a stationary bracket **412** of the upper hoist. A rod **414** has an end portion pivotally connected intermediate the ends of lever **410** and at its other end said rod has connected thereto a piston valve **415** movable in a valve chamber **418***a* of a valve block **418**. Rod **414** has a lateral extension **414***a* in the end of which is secured a pin **419** which is movable in a slot **420***a* in the valve rod of a valve **420** having spaced lands **420***b* and **420***c*. Lever **410** has a lug **410***a* projecting from one end carrying a headed screw **411** adapted to actuate a switch IG1B. Switch IG1B indicates that shutter **406** is in closed or round-holding position. One of the guide rods **402** has a head **402***a* disposed between inturned arms **421***a* of a bracket **421** secured to a rod **422** having at its other end a piston valve **423** movable in a chamber **424**. When the carrier comes into position with its chamber in member **326** aligned with the tube of the upper hoist, head **402***a* moves in between arms **421***a*. Arms **421***a* are shown in FIG. 38 as turned 90 degrees from actual position. A conduit **425** connects the end of chamber **424** to the chamber **418***b* in which valve **420** moves. A conduit **426** connects the other end of chamber **424** to a chamber **418***c* in valve block **418**. A valve **428** is movable in chamber **418***c* and a compression coiled spring **429** engages one end of valve **428**. Valve **428** has a passage **428***a* therein communicating at its ends with chamber **418***c*. Valve **428** is a pressure reducing valve. As shown in FIG. 38, PA in passage **418***d* is blocked by the upper land of valve **428**. The valve is balanced at a pressure of approximately **450** pounds. If fluid is called for or required, there will be a drop of pressure above valve **428**. Spring **429** will then raise valve **428** and PA will flow into chamber **418***c*, through passage **428***a* to passage **418***f*. Should the pressure above valve **428** rise above **450** pounds, it will move said valve downward against the pressure of spring **429** and shut off PA. A pressure of substantially 450 pounds is thus maintained in passage **418***f*. This will be referred to as PC. A passage **418***d* leads from chamber **418***c* to a source of fluid under accumulator pressure. A passage **418***e* connects chamber **418***g* to tank through a conduit **430**. A conduit **431** extends from conduit **430** to one end of valve chamber **418***b*. A passage **418***f* connects conduit or passage **426** with valve chamber **418***g* in which chamber is movable a valve **432** which is connected at one end to a lever **433**. Lever **433** is oscillatable with a shaft **434** connected at its other end to a lever **436**. Lever **436** has pivotally connected to opposite ends thereof respectively the operating plungers **437***a* and **438***a* of solenoids SG2 and SG1. Lever **436** has disposed adjacent its ends the actuating plungers of switches IG101 and IG102 respectively. Lever **433** has an end portion provided with spaced recesses **433***a* in either of which a spring pressed detent **442** is adapted to engage to hold levers **433** and **436** in their different positions. A passage **418***h* connects chamber **418***g* to chamber **418***a*. A passage **418***i* connects chamber **418***b* to chamber **418***g* at spaced points in the latter. A passage **418***j* connects chamber **418***b* to passage of conduit **426**. A passage **418***k* connects chamber **418***g* to one end of chamber **418***a*. A switch IF12 is disposed adjacent arm **421** and adapted to be actuated thereby when piston **423** is adjacent one end of its travel. Another switch IF21 is positioned to be operated by arm **421** when piston **423** is adjacent the other end of its travel.

Transfer of round from carrier to upper hoist

As stated, when a round of ammunition has been delivered to the carrier, the carrier is moved, as will be later described, and brought into alignment with the upper hoist so that the members **326** are transversely or radially aligned with the tubes **301**. The carrier and upper hoist will then be latched together by the latch **450**. When the round is to be transferred to the upper hoist, switches IF10 indicating that there is a round of ammunition in the carrier, IH4A indicating that there is no round in the upper hoist chamber, IH5A indicating that pawl **765** is in its lower position, IG1B indicating that the shutter **406** is in retracted position, IF20D indicating that the carrier is latched to the upper hoist, have been closed indicating that the upper hoist tubes are empty and that a round of ammunition is present in the carrier, an electric circuit will be closed and solenoid SG2 will be energized and will operate oscillating lever **436**, shaft **434** and lever **433**. Lever **433** will move valve **432** upward and detent **442** will enter the other recess **433***a* than that shown in FIG. 38. Fluid from valve **428** (hereinafter referred to as PC) will now pass into passage **418***d* and will move through a passage **428***a* in valve **428** to the upper part of passage **426** into passage **418***f* and around valve **432** which is now in its upper position between the lower two lands thereof to passage **418***k* and thus to the lower side of piston **415**. Valve **415** will be moved upwardly moving rod **414** upwardly. This will swing lever **410** and through the link **409** the shutter **406** will be swung to the right or clockwise about the axis of shaft **407**, as shown in FIGS. 33, 34 and 38. As portion **414***a* moves upward with rod **414**, pin **419** moves in slot **420***a* and when it reaches the end of said slot, valve **420** will be moved upwardly venting fluid from chamber **424** through conduits **425**, **418***i*, **431** and **430**. PC is then delivered from chamber **418***g*, through passage **418***f* and through passage and conduit **426** to the lower side of piston **423**, as shown in FIG. 38. Piston **423** is now moved to the left, as seen in FIG. 38, moving rod **402** and swinging bell crank levers **400**, links **398**, levers **394**, links **393** and arms **392**, which swing shafts **328** and the members **330**. These members now swing in opposite directions, as shown in FIGS. 33 and 34, about the axes of shafts **328** respectively to the successive positions shown in FIGS. 33 and 34, and the round P is moved out of member **326** and toward the tube **301** and into position to be engaged by member **406**. The upper hoist casings **301***a* are provided with suitable slots **301***a*2 through which ejector members **330** can move.

In the above described operation, the switch IG1B was actuated right after the valve **420** was moved up by rod **414**. This operates solenoid SG1, thus swinging lever **436**, shaft **434** and lever **433** to move valve **432** to the position shown in FIG. 38. PC then passes through passage **418***d*, valve **428**, passage **418***f* to chamber **418***g*, around valve **432** to passage **418***h* and to the upper side of piston **415**. Piston **415** is moved downwardly thus moving rod **414** and valve **420** downwardly. Chamber **418***a* below piston **415** is vented to tank through passage **418***k*, around valve **432**, between the two lower lands thereof to passage **418***i*, and then through conduits **431** and **430**. When valve **415** and rod **414** are thus moved downwardly, lever **410** is swung, swinging link **409**, arm **408** and shutter **406**. Shutter **406** is swung to the successive positions shown in FIGS. 38, 33 and 34. The

round is moved by members **406** into axial alignment with the tube **301**. The round engages and is guided by the member **301***e* which extends along the upper hoist chamber. As shown in FIGS. 38, 33 and 34, member **301***e* has an inner concave surface. The round of ammunition comprising the powder can and projectile is thus transferred from the carrier to the upper hoist. The round of ammunition is clamped in the upper hoist tube by shutters **406**.

The carrier control

A control means is provided for operating the carrier **300**. Referring to FIG. 44 the control means comprises a shaft **500** which is journaled in suitable bearings and comprising couplings **501**, which shaft is driven by a gear **502** secured to one end thereof which meshes with an idler gear **504** and which is in turn driven by a gear **506** secured to the shaft **600***a* which has secured thereto the pinion **314** which meshes with an drives the internal gear **310** secured to the carrier. The ratio of pinion **314** to carrier gear **310** is 1 to 16. Shaft **500** is connected through pairs of suitable beveled gears **508** and **510** and a shaft **509** to a shaft **511** carrying a pinion **512** meshing with a gear **513** on a shaft **514**. Pinion **512** is secured to a beveled gear **512***a* forming part of a differential gear assembly **515**. Said assembly comprises a spider **515***a* carrying shafts on which are journaled oppositely disposed beveled gears **515***b* meshing respectively with the beveled gear **512***a* on gear **512** and the bevel gear **516***a* journaled on shaft **518** secured to and extending from spider **515***a*. Gear **516***a* has secured thereto a pinion **516***b* meshing with a gear **517** journaled on shaft **514**. Shaft **518** has secured thereto at its other end a gear **520** with which meshes a gear **521**. (See FIG. 43.) In the embodiment of the invention illustrated, gear **520** is shown as a worm gear and gear **521** is shown as a worm. Gear **521** is connected to a shaft **522** journaled in suitable bearings **523** and which is connected through pairs of beveled gears **524** and **525** and shafts **526** and **527** to a gear **528** which meshes with a gear **530** secured to the B-end motor **532** of a hydraulic driving mechanism. The motor **532** has a drive shaft **532***a* which is the driving shaft for the training gear of the rotating mount proper.

A member **534** (see FIG. 41) rotates about shaft **518** and carries at one end a cam **534***a* positioned to operate the actuating plunger of an electric switch IF6AB. Member **534** also has at one end a beveled gear **534***b* forming part of a differential gear assembly **536**. Said assembly comprises member **536***a* rotating about shaft **518** and supporting a shaft on which are journaled beveled gears **536***b* and **536***c*. Beveled gear **536***b* meshes with a beveled gear **536***d* carried at one end of a spur gear **536***e* which rotates about shaft **518**. A gear **536***f* rotates about the hub of gear **536***e* and carries a beveled gear **536***g* which meshes with beveled gear **536***c*. Beveled gear **536***c* also meshes with a beveled gear **534***f* journaled on member **534**. Member **534***f* carries a cam **537** adapted to engage the actuating plunger of a switch IF7AB. Cam **537** is illustrated in FIG. 44*a*. It will be seen that it has two cam surfaces **537***a* and **537***b*, each approximately of 180 degrees in extent. Said surfaces are adapted to engage a plunger IF7*a* of switch IF7AB. A spring **535** urges plunger IF7*a* against cam **537**. Said spring at one end engages a contact member IF7*b* of switch IF7AB and at its other end engages a fixed member **538** in which plunger IF7*a* slides. Contact IF7*b* is adapted to engage a pair of contacts IF7*c* when plunger IF7*a* is in engagement with cam surface **537***b* and is moved with plunger IF7*a* when the latter engages cam surface **537** against the pressure of spring **535** to disengage contacts IF7*c* and to engage a pair of contacts IF7*d*. Contacts IF7*c* and IF7*d* as shown have conductors of electrical circuits respectively attached thereto. When contact IF7*b* engages contacts IF7*c*, one circuit is closed, and when it engages contacts IF7*d* another circuit is closed.

Cam **534***a* is similar in structure to cam **537** and has similar cam surfaces arranged to engage a plunger of switch IF6AB and to move a contact of said switch to engage pairs of contacts similar to contacts IF7*c* and IF7*d*.

The motor **532** (see FIG. 43) is connected to a pressure producing device or variable delivery pump **533** which has therein a swinging stroke-adjusting or tilting plate. To the end of the shaft or the trunnion of said plate is secured an arm **594**. Arm **594** is connected by a link **595** to an oscillating cam plate **596** swingable about the axis of the shaft **518**. Cam **596** has a recess into which fits member **536***a* so that movement of said cam will move member **536***a* and the gears **536***b* and **536***c* carried thereon to vary the action of the differential **536**. Cam **596** has a cam slot **596***a* therein eccentric to the axis of shaft **518** in which is movable a cam roller pivotally connected to a link **598** which is connected to member **553***a* which carries the beveled gears **553***b* and **553***c*.

The beveled gear **534***b* on member **534** meshes with a beveled gear **536***b* carried on the shaft on member **536***a*, said beveled gear **536***b* also meshing with the beveled gear **536***d* on member or gear **536***e*.

The gear **513** has secured thereto a pinion **513***a* which meshes with a gear **542** which is secured to the lower end of a shaft **546**. Shaft **546** has secured thereon a gear **544***b* and also has thereon a cam **544***c* positioned to engage the actuating plunger of an electrical switch IF14A. The shaft **546** has secured to its other end a gear **550** which meshes with gear **536***e*. Gear **536***f* meshes with a gear **552** which has thereon a beveled gear **552***a* forming part of differential gear assembly **553**. Said gear assembly comprises a member or spider **553***a* having shafts at opposite sides on which are journaled the gears **553***b* and **553***c*. Gears **553***b* and **553***c* mesh with beveled gear **552***a* and also with a beveled gear **554***a* carried on a gear member **554**. Member **552** is provided with a central sleeve **552***b* rotating about shaft **546** and members **553***a* and **554** rotate about said sleeve. Sleeve **552***b* has at its other end a gear **552***c* which meshes with a pinion **517***a* secured to gear **517** which, as stated, meshes with pinion **516***b* rotating about shaft **514**. Member **554** carries a cam **554***b* positioned to engage the actuating plunger of an electrical switch IF15A.

The gear **554***b* meshes with a gear **558** shown as in a plane at ninety degrees to its actual plane and carried on a shaft **559**. The ratio from gear **506** through gears **504**, **502**, shaft **500**, gears **508** and **510** to pinion **512** is as shown in FIG. 44, one to one. The ratio from pinion **512** through gear **513**, pinion **513***a*, gear **542** and gear **544***b* to gear **558** is one to nine. This is half the ratio of the carrier pinion **314** and carrier gear **310**, since there are two hoists 180 degrees apart. An eccentric **560** surrounds shaft **559** and is disposed in an eccentric strap **561** to which is secured a link **562**. Eccentric **560** has secured therein a pin **563** fitting into a block **564** which is movable in an elongated slot in a Scotch yoke **566** extending some distance to one side of gear **558**.

Gear **554** meshes with a gear **568** shown as disposed in a plane at ninety degrees to its actual plane and carried on a shaft **569** to which is secured an eccentric **570**. A strap **571** surrounds eccentric **570** and has secured thereto a link **572**. A pin **573** is secured to eccentric **570** and fits in a block **574** which is slidable in an elongated slot in a Scotch yoke **576***c* which extends to one side of gear **568**. Member **566** has pivotally connected thereto the rod **576***a* of an anchor piston or valve **576** movable in a chamber **575***a* of a valve block **575**. A piston **577** is movable in chamber **575***a* and has a reduced end engaging the end of piston or valve **576**. Piston **577** has a bore therein which extends a compression coiled spring **578**, said spring at its other end engaging the bottom of chamber **575***a* and surrounding a positioning lug at said bottom. Piston **577** has an outwardly extending peripheral flange **577***a* at its lower end adapted to engage a shoulder formed by an

enlargement of chamber 575*a* to limit the upward movement of piston 577. A passage 575*b* communicates with chamber 575*a* adjacent the central portion thereof. Passage 575*c* communicates with chamber 575*a* at the upper end thereof above valve 576 and also with said chamber at the lower end thereof below valve 576 through passage 575*d*. Passage 575*b* is connected directly to tank at all times. The end of member 566 has pivotally connected thereto a link 579 (see FIG. 42) in turn pivotally connected to a link 580 which is at its other end pivotally connected to the rod 582*a* of a speed control valve 582 which is movable in a chamber 584*a* of a valve block 584. (See FIGS. 42 and 41.) Member 576*c* is pivotally connected at its end to link 580.

The member 576 has pivotally connected thereto intermediate its ends one end of rod 586*a* of a piston or valve 586 movable in a chamber 587*a* of valve block 587. Another valve 588 is movable in chamber 587*a* and has a reduced end dapted to engage one end of valve 586. Valve 588 is similar in structure to valve 577 and is bored to receive one end of a compression coiled spring 585, the other end of which engages the bottom of passage 587*a* and surrounds a positioning lug at said bottom. Valve 588 has an outwardly extending peripheral flange at its bottom engaging a shoulder formed by an enlargement of passage 587*a* to limit upward movement of valve 588. A passage or conduit 587*b* communicates with chamber 587*a* adjacent the upper end thereof above valve 586 and a passage 587*c* extends from passage 587*b* to adjacent the lower end of chamber 587*a* below valve 586. The dot and dash line about the upper portion of FIG. 44 represents the outline of a casing in which the parts enclosed in said line are enclosed.

The link 562 is pivotally connected to the rod 590*a* of a deceleration initiator valve 590 movable in a chamber 584*b* in valve block 584 and operable to start the deceleration of the carrier when it moves to the upper hoist. Link 562 is moved by eccentric 559. Link 572 is pivotally connected to the rod 592*a* of another deceleration initiator valve 592 movable in a chamber 584*c* in valve block 584 and operable to start the deceleration of the carrier when it moves to the lower hoist. Link 572 is moved by eccentric 570.

The shaft 600*a* forms the driving shaft of the fluid motor 600 which drives the carrier. Said motor is supported upon and moves with the mount proper and is supplied with operating fluid through conduits 601 and 602. Case drainage conduit 600*b* leads to tank. Conduit 601 communicates with a passage 584*d* in valve block 584 which in turn communicates with a passage 584*eh* extending to valve chamber 584*a* and to a valve chamber 584*e* in which is movable a by-pass valve 604. The conduit 602 communicates with a passage 584*f* in block 584 which in turn communicates with a passage 584*g* communicating with chamber 584*a* and with chamber 584*e*. A passage 584*h* connects chambers 584*a* and 584*e*. A passage 584*i* extends to valve chamber 584*e* and is connected to a conduit 605 extending to an accumulator containing liquid under pressure or PA. A passage 584*j* extends from one end of passage 584*a* to a chamber 584*k* in which moves a valve 606 adapted to control the direction of movement of the carrier. Valve 606 is connected to a link 607 pivotally connected at its other end to a lever 610 swingable about a stationary pivot 611. Lever 610 has pivotally connected thereto at one end the plunger or core 612*a* of a pull type solenoid SF4. Lever 610 has pivotally connected thereto adjacent its other end the plunger or core 614*a* of pull type solenoid SF3. Lever 610 has portions positioned to engage actuating plungers of electrical switches IF104A and IF103A respectively. The valve 606 is influenced by a compression coiled spring 609. Spring 609 holds and retains valve 606 in central position, as shown in FIG. 41, when solenoids SF3 and SF4 are de-energized. A passage 584*m* extends from chamber 584*k* to chamber 584*a*. A passage 584*n* extends from one end of chamber 584*e* to a chamber 584*o* in block 584 in which is movable a bypass control valve 608. Valve 608 is moved to the position shown in FIG. 41 by a spring 613 when push type solenoid SF5 to be later described is de-energized. A passage 584*p* communicates with chamber 584*o* and extends to chamber 584*c*. Chambers 584*b* and 584*c* are connected by passages 584*q*, 584*r*, 584*s* and 584*t* which are controlled by the spaced lands on valves 592 and 590. Valves 592 and 590 are deceleration initiator valves operating when the carrier approaches alignment with the lower or upper hoists respectively. Passages 584*q*, 584*s* and 584*t* communicate with a passage 584*t*1 which extends from tank to spaced passages 584*t*2 in which are movable respectively relief valves 591. The chambers 584*k* and 584*o* are connected by passages 584*u*, 584*u*1, 584*u*2 and 584*u*3, which are controlled by the spaced lands on valves 606 and 608. Passages 584*u*, 584*u*1 and 584*u*3 also communicate with a passage 584*u*4 which leads to tank. A passage 584*w* extends from chamber 584*o* to chamber 584*e*. A hoist selector valve 618 is movable in a chamber 584*x* in block 584 and is connected by a link 619 to a lever 620 swingable about a fixed pivot 621. Lever 620 is pivotally connected adjacent one end to the actuating plunger or core of a pull type solenoid SF2 and is pivotally connected adjacent its other end to the actuating plunger or core of a pull type solenoid SF1. Said lever has portions thereof positioned to engage the actuating plungers of electrical switches IF101AB and IF102AB. Said lever has an end portion with spaced recesses therein into which a spring pressed detent 627 is adapted to enter to hold said lever in one or the other of its positions. Solenoid SF2 positions valve 618 to cause the carrier to move to the lower hoist and solenoid SF1 positions it to cause the carrier to move to the upper hoist.

Conduit or passage 575*c* extends to and communicates with chamber 584*x*. A passage or conduit 587*b* also communicates with valve chamber 584*x*. The passage 584*bb* extends from chamber 584*x* to chamber 584*c*. A passage 584*cc* also extends from chamber 584*x* to chamber 584*b*. Passage 584*dd* extends to tank and has branches connecting with chamber 584*x*. A passage 584*ee* extends from the pressure passage 584*i* to a chamber 584*ff* in which is disposed a pressure regulating valve 628 having a stem at one end surrounded by a compression coiled spring 629 engaging said valve and one end of chamber 584*ff*. Passage 584*ee* also communicates with the passages 584*t*2 in which relief valves 591 are movable. A passage 584*gg* has branches communicating with chamber 584*ff* and extends to a passage 584*hh* communicating with tank and with a chamber 584*ii* in which is movable another pressure valve 630. Valve 630 has a stem at one end extending into a compression coiled spring 630*a* engaging said valve and engaging one end of chamber 584*ii*. It will be noted that valves 628 and 630 have portions with openings extending therethrough. Passage 584*hh* also communicates with a chamber 584*jj* in which is movable a pressure regulating valve 631 having a stem at one end surrounded by a coiled compression spring 632 engaging valve 631 and one end of chamber 584*jj*. Like valves 628 and 630, valve 631 has a passage extending through one portion thereof. The valves 591 engage small plunger valves 634 movable in passages 584*kk* and 584*mm* having portions axially aligned respectively with passages 584*t*2. Passages 584*kk* and 584*mm* communicate with a passage 584*nn* having a restricted orifice therein between passages 584*kk* and 584*mm*. A passage 584*oo* communicates with chamber 584*jj* and with chamber 584*a*. Spaced passages 584*pp* and 584*qq* communicate with chambers 584*ii* and 584*a* respectively. A passage 584*j*1 extends from chamber 584*jj* to chamber 584*a*.

Bypass control valve 608 has pivotally connected thereto a link 636, the other end of which is pivotally

connected to a lever **637** swingably mounted about a fixed pivot **638**. The other end of lever **637** is pivotally connected to the operating plunger or core of a solenoid SF5. Lever **637** has a portion adapted to engage the actuating plunger of an electrical switch IF105A when solenoid SF5 is energized.

The direction of rotation of the carrier **300** relative to the upper hoist is determined by the direction of displacement of the valve **582** from its central or neutral position. The speed of rotation of the carrier is dependent upon the magnitude of said displacement. Valve **604** is a two-position valve, which, in the up position shown in FIG. 41 blocks PA to valve **582** and bypasses the flow of liquid from motor **600** which drives the carrier. Referring to FIG. 41 it will be seen that passage **584***i* to which PA is delivered is closed by valve **604** in its up position. It is of course necessary to bypass the fluid from hydraulic motor **600** when the carrier is not in power operation. When valve **604** moves to its down or lower position, PA can pass into passage **584***i*, through passage **604***b* in valve **604** and into passage **584***h* and thus to chamber **584***a* or valve **582**. It will also be seen that when valve **604** is in its lower or down position that bypass passages **584***g* and **584***eh* are closed by said valve so that there would be no bypassing of the liquid from motor **600** through passage **604***d* in valve **604**. Solenoid SF5 is energized whenever the mount is in power operation. Consequently valve **604** bypasses the motor **600** only when the mount is not in power operation. It will be seen that valve **582** has connected thereto the two link structures connected to members **566** and **576***c* respectively. The one linkage is operated by the Scotch yoke **576***c* and gear **568**. This linkage has an anchor piston **588** attached thereto. The other linkage is operated by yoke **566** and gear **558**. Said other linkage has an anchor piston **577** attached thereto. Said linkages are effective in positioning valve **582** only if their respective anchor pistons are under pressures.

Since the response for the carrier control is fed through shaft **500** to differential **515** and the response when training the mount or gun is fed into said differential through shaft **518**, the result will indicate the position of the carrier relative to the deck or to the lower hoist from which lower hoist it will have started. This result is fed into the differential **553** through reduction gears **516***b*, **517**, **517***a* and **552***c*. It will be noted that both differential **536** and differential **553** have an input from the tilting box or stroke-adjusting plate of the pump **533** of the training gear. The movement of the stroke adjustment plate is proportional to the speed of motor **532**. This input from the said pump and training gear alters the result fed into differential **553** from differential **515**. Thus the position of gear **568** indicates the position of the carrier relative to the lower hoist plus a value which is equivalent to train speed. This is necessary when the carrier stops at the lower hoist with the gun or mount rotating because if the carrier is to be held stationary relative to the lower hoist, it must be rotating relatively to the mount and gun and must therefore be rotated oppositely to the gun or mount and at the same speed as the mount. When the carrier is latched to the lower hoist and the "mount proper" is rotating in training, valve **582** must be moved an amount which will cause the carrier, or the motor **600** to rotate the carrier, relatively to the mount and at the same speed as the mount. This offsets the relative motion between the mount and the carrier and the carrier is stationary relative to the lower hoist. The said input is fed into the differentials **536** and **553** by means of the link **595** and cam **596**, which latter swings the spider portion **553***a* of differential **553**. Cam **596** also swings the spider **536***a* of differential **536**.

When a cycle of the carrier to the lower or to the upper hoist is initiated, the carrier completes the cycle in the shortest possible time. The speed of direction of the mount and gun as well as the position of the carrier relative to its destination must therefore be taken into consideration in determining the direction of rotation of the carrier. If the carrier is more than 45 degrees from its destination, the electrical switches IF6AB will be energized. It will be noted that the cams **537** and **534***a* indicate carrier position relative to the upper and lower hoist respectively. These values are altered however by the said input into differential **553** from the tilting box or adjusting plate of the pump **533**.

When the mount is not in power operation, a switch on the control panel at the mount captain's position is open. This de-energizes solenoid SF5 and valve **608** is moved to the right by spring **613** to the position shown in FIG. 41. Solenoid SF5 is a push solenoid. When valve **608** is in said position, reduced pressure or PC can now pass through passage **584***p*, around valve **606**, through passage **584***u***2**, through valve **608** and through passage **584***w*, to the lower side of valve **604**. Valve **628** reduces PA to a pressure of about 200 pounds, hereinafter called PC. Valve **604** will be moved to its upper position, as shown in FIG. 41. When valve **604** is in this position it bypasses the hydraulic motor **600**. The fluid from said motor is free to pass through conduit **602** and passage **584***f* to passage **584***g*, then around valve **604** to passage **604***a*, through passage **584***eh* to passage **584***d*, to conduit **601** and back to said motor. When the carrier is to be put into power operation said switch on said control panel will be closed. This energizes solenoid SF5 and valve **608** is moved to the left, as shown in FIG. 41. PC from passage **584***p* will now move around valve **606**, through passage **584***u***2**, around valve **608** to passage **584***n* and to the top of valve **604**, moving valve **604** to its lower position. This allows PA to pass through passage **604***b* thus rotating the B-end of motor **600** which will drive the carrier to the desired position. This PA passes from passage **584***i* through passage **604***b*, through passage **584***h* which is now in alignment with passage **604***b*, through chamber **584***a* between the lower two lands of valve **582**, then through passage **584***ee* to passage **584***d* and conduit **601** to the motor **600**, then through conduit **602** to passage **584***g*, around valve **582** to passage **584***jl* through chamber **584***jj*, around valve **631** and through passage **584***hh* to tank. Valves **608** and **604** will remain in the latter positions to which they have been moved until solenoid SF5 is again de-energized by throwing the switch on the captain's control panel.

Passage **584***n* from valve **608** to the top of the valve **604** contains an orifice **584***vv*. In the event that solenoid SF5 is de-energized during a carrier cycle, said orifice will restrict the flow of fluid from valve chamber **584***e* insuring that the carrier cycle will be finished before valve **604** can block accumulator pressure and bypass the B-end of motor **600**.

Carrier to lower hoist cycle

A cycle of movement of the carrier from the upper hoist to the lower hoist will now be described. When a cycle of movement to the lower or to the upper hoist is initiated, it is desired to complete the cycle in the shortest possible time. Let it be assumed that the carrier has just completed a cycle to the upper hoist and the upper hoist detent roller **450** has dropped into the recess **300***k* in the carrier. This moves the detent and lever **451**, which lever closes a contact on switch IF20 and this indicates that the carrier is now in position to transfer a round to the upper hoist.

Assuming that the carrier is farther than 45 degrees from registry with the lower hoist, either solenoid SF3 or SF4 will be energized depending upon whether a clockwise rotation or a counterclockwise rotation will get the carrier to the lower hoist in the shortest period of time. As stated, cams **534***a* and **537** indicate carrier position relative to the upper and lower hoist respectively. A contact on switch IF7AB will be closed by cam **537** and this will close an electrical circuit and energize either

solenoid SF3 or SF4 depending upon whether a clockwise rotation of the carrier has been selected.

Cam 537 controls the direction of rotation of the carrier when moving to the lower hoist, while cam 534*a* controls the direction of rotation of the carrier when moving to the upper hoist. The switches IF6AB and IF7AB are either in one of two positions. Their actuating plungers are urged against their respective cams and the switches move to one position or the other when permitted to do so by the lower side of cams 534*a* or 537. Said plungers are moved to put the switch in the other position by the high side of said cams respectively.

When solenoid SF2 operates, as hereinafter described, it pivots lever 620, and actuates switch IF102AB. This switch is in series with switch IF15A and IF7AB. Switch IF7AB has two separate circuits, one of which includes SF3 and the other of which includes solenoid SF4. One circuit includes contacts IF7*c* and the other circuit includes contacts IF7*d*. (See FIG. 41*a*.) The position of cam 537 determines which circuit is energized. In this case it is assumed that the circuit is completed through contacts IF7*c* (FIG. 41*a*) and solenoid SF3 which causes clockwise rotation of the carrier toward the lower hoist.

Valve 606 will then be moved to the right, as shown in FIG. 41. Solenoids SF3 and SF4 are pull solenoids. With valve 606 moved to the right, PC can now pass from passage 584*p* around valve 606 to passage 584*m* and to the upper end of valve 582. This valve is moved downwardly from its central or neutral position shown in FIG. 41.

When the following switches are operated, namely switch IF10, indicating that there is no round of ammunition in the carrier chamber, switch IF12 indicating that the transfer mechanism of the upper hoist is fully retracted, switch IG1*b* indicating that the shutters 330 of the carrier are fully retracted or closed, switch IF20 indicating that the carrier is latched to the upper hoist, and switch IR6 indicating that there is sufficient PA to effect a cycle, an electrical circuit will be closed and solenoids SF7 and SF9 are energized. Valve 662 will be moved downwardly and this will vent chamber 390*a* at the lower side of valve 660 to tank and pressure in passage 390*c* will act on the top of valve 660 moving it downwardly, thus moving rod 388 downwardly and breaking the toggle 383 so that spring 385 can move lever 381 upwardly. Detent roller 380 will now move against the bottom surface of the bottom carrier flange 300*a* and be ready to drop into recess 300*j* when the carrier comes into registry with the lower hoist.

When solenoid SF7 is energized, valve 681 will be moved downwardly shutting off communication to tank so that the pressure from passage 460*c* is now placed on the top and bottom of valve 680. This valve will be moved downwardly since it has a greater top surface and toggle 453 will be straightened, thus swinging lever 451 to move roller 450 out of its recess 300*k* and unlatching the carrier from the upper hoist. Lever 451 moves away from switch IF20A and it in turn energizes solenoid SF2. Solenoid SF2 shifts valve 618 to the right, as shown in FIG. 41. This position of valve 618 determines that the carrier will move to the lower hoist. As above described, with valve 604 down, PA to motor 600 will now rotate the carrier.

When the carrier gets within 45 degrees of registry with the lower hoist, the contacts of switch IF15A is permitted to open by its cam 554*b* and this de-energizes solenoid SF3. Valve 606 will now be moved to its central position by its spring 609. This shuts off pressure from the lower side of valve 582. Since the carrier is moving to the lower hoist, eccentric 570 will now move valve 592 toward the position shown in FIG. 41 and PC will pass from passage 584*p*, around valve 592, through passage 584*bb* to chamber 584*x* and around valve 618 to and through conduit 587*b*, thus putting pressure in the top and bottom of chamber 587*a*. Anchor piston or valve 588 is moved upwardly until its flange engages the shoulder in the valve block 587 and valve 586 is moved downwardly into engagement with member 588. Valve 586 and its rod 586*a* are now locked in position and the yoke 576*c* actuated by block 574 now begins to move the lever formed by the yoke 576*c* which is pivoted to rod 586*a* and valve 582 is gradually raised to its central position shown in FIG. 41. At the instant the anchor piston anchors, eccentric pin 573 is in a position 90 degrees clockwise from the position shown in FIG. 44, and rotating in a counter-clockwise direction. As valve 582 moves upwardly, it gradually cuts off the passage 584*gg* and causes a build-up of pressure in chamber 584*a* above the lower land of said valve. Fluid is passing into said chamber through passage 584*eh*. Sail built-up pressure acts on the top of valve 630 to move it downwardly against the pressure of spring 630*a* and flow to passage 584*hh* or to tank is gradually cut off. Valve 582 is thus decelerated and moved to central position. The cutting off of the liquid in said passages governs the rate of deceleration of the carrier, which deceleration follows a predetermined curve, and the carrier is substantially decelerated as roller 380 comes into alignment with the notch 300*j* permitting said roller to drop into said notch. The carrier is now locked to the lower hoist in alignment therewith. It will be seen, as stated, that valves 590 and 592 are thus deceleration initiator valves, one acting when the carrier moves to the lower hoist and the other acting when the carrier moves to the upper hoist. Valve 582 will hold the carrier in correspondence with the hoist to which it is latched.

Valve 582, as stated, is moved to its central position and the carrier stops in registry with the lower hoist and is latched thereto. This is on the assumption that the gun and mount proper are not moving in training. If the gun and mount proper are moving in training, valve 582 will not be moved to its central or neutral position but will be moved through the yoke 576 and gear 568 to a position to rotate the carrier in either direction to compensate for the training movement.

Slot 596*a* moves arm 598 to rotate member 553*a* six degrees. Arm 594 is two-thirds the length of arm 595. The carrier rotates up to 300 degrees while the gun and mount proper rotate up to 40 degrees per second. Six degrees movement of arm 598 and member 553*a* will move valve 582 through gear 568 enough to rotate the carrier 40 degrees per second.

Carrier to upper hoist cycle

A cycle of movement of the carrier from the lower hoist to the upper hoist will now be described. Let it be assumed therefore that the carrier has just completed a cycle to the lower hoist and that the lower detent roller 380 has dropped into the notch 300*j* in the lower ring 300*h* of the carrier. (See FIG. 40.) When the lower hoist detent roller 380 drops into its notch, it closes a contact on switch IF1, which indicates that the lower hoist can now hoist the next round of ammunition. Assuming that the carrier is farther than 45 degrees from correspondence with the upper hoist, either solenoid SF3 or SF4 will be energized depending upon whether a clockwise rotation or a counter-clockwise rotation will produce the shortest cycle. Cams 534*a* and 537, as stated, indicate carrier position relative to the upper and lower hoists subject to a correction by cam 596. Switch IFGAB controls two circuits, one of which will energize solenoid SF3 and the other of which will energize solenoid SF4. Cam 534*a* actuates switch IF6AB to close said circuits just as cam 537 actuates switch IF7AB. Thus either solenoid SF3 or SF4 will be energized depending upon whether a clockwise rotation or counter-clockwise rotation of the carrier has been selected. When SF1 operates, as later described, it swings lever 620 and actuates switch IF101AB. This switch is in series with switches IF5AB and IF7AB. The posi-

tion of cam 534*a*, as stated, represents the position of the carrier relative to the upper hoist. Let it be assumed that cam 534*a* acts to energize solenoid SF4 and that cam 534*a* is thus in position to select a counter-clockwise rotation. When solenoid SF4 is energized, valve 606 will be moved to the left, as shown in FIG. 41. PC can now pass from passage 584*p* around valve 606 to passage 584 and to the lower end of valve 582. This valve is thus moved upwardly from the central or neutral position shown in FIG. 41. When switches IF10A, IF12, IG1 and IR6 are closed, as set forth above in describing the cycle to the lower hoist, and also switch IF1 indicating that the carrier is latched to the lower hoist, an electrical circuit is closed and solenoids SF6 and SF9 are energized. Valve 681 will be moved upwardly to the position shown in FIG. 41, and this will vent chamber 460*a* at the upper side of valve 680 to tank through passage 460*d* and pressure in chamber 460*a* will act on the bottom of valve 680 moving it upwardly, thus moving rod 458 upwardly and breaking the toggle 453 so that spring 459 can move lever 451 downwardly. Roller 450 will now move against the top surface of the top carrier ring and be ready to drop into notch 300*k* when the carrier comes into registry with the upper hoist. When solenoid SF9 is energized, valve 662 will be moved upwardly shutting off communication to tank so that pressure from passage 390*c* is now placed on the top and bottom of valve 660. This valve will be moved upwardly since it has a greater bottom surface and toggle 383 will be straightened, thus swinging lever 381 to move roller 380 out of its recess 300*j* and unlatching the carrier from the lower hoist. Lever 381 moves away from switch IF1 and said switch now acts to energize solenoid SF1. Since valve 582 has been moved upwardly, PA now passes from passage 584*i*, through passage 604*b*, through passage 584*h* which is now in alignment with passage 604*b*, through chamber 584*a* between the lower two lands of valve 582, then through passage 584*eh* to passage 584*d* and conduit 601 to the motor 600, then through conduit 602 to passage 584*f*, to passage 584*g*, around valve 582 to passage 584*j*1, through chamber 584*jj*, around valve 631 and through passage 584*hh* to tank. It will be noted that this path to the motor is opposite to that in the description of the cycle to the lower hoist. The carrier being unlatched from the lower hoist now rotates in a counter-clockwise direction toward alignment with the upper hoist. When the carrier gets within 45 degrees of alignment with the upper hoist, one of the contacts of switch IF14A will be permitted to open by cam 544*c* and this will deenergize solenoid SF4. Valve 606 will now be moved to central position by spring 609. This will shut off pressure from the lower side of valve 582. Since the carrier is moving to the upper hoist, eccentric 560 will now move valve 590 to the position shown in FIG. 41.

Reduced pressure now passes from passage 584*p*, around valve 592, through passage 584*r*, around valve 590, through passage 584*cc* to chamber 584*x*, around valve 618 between the left-hand lands thereof, and through conduit 575*c* to valve chamber 575*a*. Pressure is placed on the top and bottom of valve 576 and anchor piston or valve 577 is moved upwardly until its flange engages the shoulder in chamber 575*a* and valve 576 is moved downwardly in engagement with valve 577. Rod 576*a* is now locked in position and the yoke 566 actuated by block 564 now begins to move the lever formed by yoke 566 which is pivoted to rod 576*a* and valve 582 is gradually moved downwardly to its central position, as shown in FIG. 41. As valve 582 moves downwardly, it gradually cuts off the passage 584*j*1 and this reduces the fluid flow through said passage. This causes a build-up of pressure in chamber 584*a* below the top land of valve 582. Fluid is entering chamber 584*a* through passage 584*g*. This built-up pressure acts on the bottom of valve 631 moving it upwardly against the pressure of spring 632. Valve 631 then acts to gradually cut off the flow of fluid from chamber 584*jj* to tank passage 584*hh*. Valve 582 is thus decelerated and moves to its central position. Valves 630 and 631 are called liquid metering valves. Only so much liquid can pass through said valves for a given position of valve 582. Springs 630*a* and 632 will be set for a certain pressure. As above described, as valve 582 moves to restrict passages 584*j*1 and 584*qq*, pressure builds up in chamber 584*a*. This pressure acting on lower end of valve 631 will move it upwardly against the pressure of spring 632 and the outlet from chamber 584*jj* into passage 584*hh* will be restricted and the flow of liquid decreased. Similarly the increased pressure in chamber 584*a* would act on the top of valve 630 and move it downward against the pressure of spring 630*a* so that it would restrict the outlet from the chamber between the lands of valve 630 into passage 584*hh*. When valve 582 moves to restrict flow into passages 584*j*1 and 584*qq*, the pressure in said passages drops. The decrease in the flow of liquid caused by valves 630 and 631 is substantially in direct proportion to the restriction of passages 584*j*1 and 584*qq* by valve 582. The gradual cutting off of the liquid in said passages 584*j*1 and 584*hh* as above described, decelerates the carrier and it is substantially decelerated as roller 450 comes into alignment with the notch 300*k* permitting said roller to drop into said notch. The carrier is now locked to the upper hoist in alignment therewith. As above stated, valves 590 and 592 are deceleration initiator valves.

As stated, the upper hoist moves with the mount proper and thus with the gun in its training movement. The motor which drives the carrier is mounted on the central column of the mount proper. It will be seen therefore that to bring a roller 450 into alignment with the recess 300*k* in the carrier it is only necessary to rotate the carrier to a certain point. It will be noted that no differential is necessary between the motor 600 and the connection to Scotch yoke 556. The mount proper carrying the upper hoist and the carrier rotate together when the carrier is latched to the upper hoist.

With the carrier latched to the lower hoist there is relative movement between the carrier and the mount during training and the carrier must be rotated in a direction opposite that of the training movement and at training speed. This is accomplished by differential 553 through gear 568.

It may again be stated that the direction of rotation of the carrier is selected by which the carrier will come into registry with the respective hoist in the shortest period of time. The shortest period of time does not necessarily mean that the carrier will take the shortest path. To select the proper direction of rotation both the speed and direction of rotation of the mounts evaluated in terms of distance must be considered. The carrier moves a great deal faster than the mount proper in the latter's movement in training. In practice the carrier reaches a maximum velocity of 300 degrees per second. The gun and mount proper in training reach a maximum velocity of 40 degrees per second. Shaft 511 which feeds into differential 515 represents position of the carrier relative to the mount proper. Shaft 518 feeding into differential 515 represents the position of the mount proper relatively to the deck and thus to the lower hoist. The result or output of differential 515 which is indicated by gear 516*a*, is thus the position of the carrier relative to the deck or lower hoist. Since shaft 511 represents the position of the carrier relative to the mount proper, this is transmitted without modification to gear 558 through gears 512, 513, 513*a*, 542 and 544*b*.

The result of differential 515 represnted by gear 516*a* is fed through gears 516*b*, 517, 517*a* and 552*c* to member 552*b* and 552*a* of differential 553. The result of differential 553 is varied by cam 596 to link 598, said cam and link representing speed and direction of the mount proper in its training movement. The total and final result of differential 553 is represented by gear 554 and

is transmitted to gear **568**. The result of differential **515** is fed by gear **516***a* through gears **516***b*, **517** and **517***a* to member **552** which through gear **536***f* feeds into differential **536**. The result of this differential is varied by cam **596** actuated from the stroke-adjusting member **594** of pump **532**. Said member **594** indicates both direction and speed of the mount proper. The result from differential **536** represented by gear **534***f* and cam **537** represents the actual position of the carrier relative to the lower hoist modified by cam **596** acting through differential **536**. This is necessary to take into consideration the speed and direction of the mount proper. Shaft **511** representing relative rotation of the carrier to the mount proper drives member **536***e* through gears **512**, **513**, **513***a*, **542**, **544***b* and **550**. The result of the differential comprising gears **534***d*, **534***b* and **536***b* is varied by cam **596** and this result is represnted by member **534** and cam **534***a*. This cam represents the position of the carrier relative to the upper hoist modified by the speed of the gun or mount proper in training.

As above stated, when the carrier gets within 45 degrees of registry with either the upper or lower hoist, its control is shifted from cams **534***a* and **537** and solenoids SF3 and SF4 to gears **558** and **568** respectively. These gears with the mechanisms actuated thereby control valve **582** and determine its position. As above stated, when the carrier has been moved to the lower hoist and latched thereto, if the mount proper is training, valve **582** will be positioned by gear **568** to rotate the carrier relative to the mount proper and in the opposite direction and at the same speed as training speed. This will hold the carrier stationary relative to the lower hoist. If the carrier is moved to the upper hoist and latched thereto, valve **582** is moved by gear **558** and the mechanism operated by said gear to its neutral position. The carrier and mount proper and the upper hoist would then rotate together in any training movement.

If the carrier is less than 45 degrees away from its destination at the beginning of a cycle, movement of control valve **582** is not initiated by solenoids SF3 and SF4 and their associated switches IF6AB and IF7AB. Said solenoids are prevented from operating by the respective cams **554***b* and **544***c* and switches IF14A and IF15A. Since the carrier is less than 45 degrees away from its destination, valves **590** or **592** port pressure PC to its associated anchor piston **576** or **586**. If the carrier has completed a cycle to the upper hoist, piston **576** is anchored. If in cycling to the lower hoist the carrier is less than 45 degrees away, the cycle is initiated the instant SF2 is energized. Under this condition valve **592** has already ported PC as far as valve **618**. When SF2 is energized, anchor piston **586** anchors and in doing so, shifts valve **582** to start the flow of PA to the driving motor **600**.

THE UPPER HOIST

As previously stated, an upper hoist is provided which receives the round of ammunition and delivers it to the cradle. (FIG. 46.) Said supper hoist is secured by suitable brackets **303** to the portion **302***a* of the central column **302**, which portion is secured to the lower end of a frame **14***a* in turn secured to frame **14**. Frame **14***a* thus depends from the gun support or mount proper. Said hoist is thus carried by and moves with the mount proper and gun in the training movement of the gun. Said upper hoist includes casing **301** disposed 180 degrees apart, which have passages therein forming the tubes of the hoist, into which the round of ammunition is received and in which it is moved. (See FIGS. 29, 31, 33, 34 and 38 previously described.) These may be called right and left-hand tubes. As already described, the round of ammunition is transferred to these tubes by the carrier. Said casings **301** are carried by brackets **303**, and an endless chain **704** is disposed in and moves in each of said casings and thus in the passages or tubes therein. Casings **301** are divided along a longitudinal plane and the parts thereof have flanges therein connected by bolts **301***f*. Said flanges are spaced for some distance at **301***g* to accommodate a wear plate (not shown) at one side of the hoist tube. Chain **704** runs over an upper sprocket **705** and a lower sprocket **706**. Said sprockets are secured to shafts **707** and **708** respectively and shaft **707** is journaled in ball bearings **710** mounted respectively in the end portions of casings **301**. Said shaft **707** of the upper sprocket projects at one side of casing **301** (see FIG. 49) and is provided with a splined end over which a crank may be inserted for manually turning said sprocket and operating said hoist. The lower sprocket **706** is arranged for some movement to tighten chain **704**. A rod **712** is provided which is pivoted at one end to casing **301** and carries collars between which is disposed a compression coiled spring **713**. One of said collars **714** engages a member **715** which is secured to a shaft **716** in turn connected to an eccentric **725** about which sprocket **706** rotates on ball bearings **706***a*. Shaft **716** projects through a hole **301***a*2 in casing **301**. Another shaft **711** passes through said eccentric and is secured in hubs **301***a* of casing **301**. Shafts **711** and **716** are at opposite sides of the central axis of lower sprocket **706**, and eccentric **725** moves about the axis of shaft **711**. Spring **713** thus exerts tension tending to move the eccentric **725** about the axis of shaft **711** and this will move sprocket **706** and maintain chain **704** under a constant tension.

Chains **704** also run over driving sprocket **719** carried on shafts **717** and **718** respectively journaled in casings **301**. (See FIGS. 45 and 47.) Each of the shafts **717** and **718** has secured to its outer end a clutch member **720** having a multiplicity of splines on its periphery. Each member **720** is adapted to be engaged by an internally splined clutch member **709** which slides on member **720**. Each of said sprockets **719** is provided with a splined portion **719***a* adapted to be engaged by its respective member **709**. Each member **709** is provided with flanges forming a clutch groove **709***a* in which are disposed at opposite sides thereof clutch rollers carried on a clutch lever **721** suitably journaled in the casing **702**. By shifting lever **721** each clutch member **709** may be moved over and engage its respective member **722** and this will connect sprocket **719** with clutch **720** and thus with its respective shaft **717** or **718**. This clutch is provided in case one of the hoists would be rendered inoperative as in action. Said one of the hoists could then be disconnected from its drive shaft and the other hoist continued in use.

Shafts **717** and **718** each carry a gear **722** with which meshes a pinion **723** secured to a shaft journaled in suitable bearings in the sprocket **719**. Gear **723** carries a pair of pins **724** which when in a certain position align respectively with a pair of holes **719***b* in sprocket **719**. When the sprocket is in position with pins **724** in such alignment, the clutch members can be engaged. In any other position they cannot be engaged. This feature insures that the clutch will also be engaged with the sprockets and chains **704** in proper synchronism with the other parts.

Shafts **717** and **718** are provided respectively with beveled gears **726** disposed at opposite sides of and meshing with a beveled gear **727** secured to a driving shaft **728**. Shaft **728** is driven by a suitable hydraulic pump and a motor unit **729** mounted on one casing **301** Shafts **717** and **718** as well as gears **726** and **727** are housed in suitable housings **301***a*1 secured to casing **301***a*. As shown in the schematic view FIG. 51, fluid is supplied to motor unit **729** through conduits **730** and **731**. The upper hoist is a one way hoist and the chain **704** in the tube of each casing **301** is reversed in its direction of travel to give the upward and downward movement. The chains and tubes in right and left-hand casings **301** thus constitute shuttle type hoists and when the pawl (later described) on one chain is moving upwardly, the pawl on the other chain is moving downwardly.

The movement of the hoists is electrically and hydraulically controlled. A valve block **734** is provided having a valve chamber **734***a* therein in which is movable a solenoid operated control valve **735**. (See FIG. 51.) Valve **735** is connected to a lever **736** carried on a shaft **737** journaled in suitable bearings in casing **702** and which carries a lever arm **738**. Lever arm **738** has connected to opposite ends thereof links which are respectively connected to the actuating plungers of solenoids SH3 and SG3 which are of the push type. Lever **736** is operatively connected to valve **735** to reciprocate the same, and also provided with spaced recesses **736***a* in either one of which a spring pressed detent **742** is adapted to seat for holding lever **736** in either of its positions. Lever **738** is arranged to engage the actuating plungers of switches IG103A and IH103A. A valve **746** is movable in a valve chamber **734***b* in block **734** having a central land and spaced end lands, each of the latter being engaged respectively by compression coiled springs **747** and **748** which at their other ends engage the ends of chambers **734***b*. Block **734** also has therein valve chambers **734***c* and **734***d* in which are respectively disposed spring pressed pressure controlling valves **750** and **751**. The block **734** also has therein a valve chamber **734***e* in which is movable a flow control valve **752** engaged at one end by a compression coil spring **753**. Spring **753** at its other end engages one end of chamber **734***e*. Valve **752** is bored to be movable on a spindle portion **734***f* of block **734** and has a passage **752***a* therethrough which communicates with a chamber **752***b*. Block **734** has a passage **734***g* extending thereinto to which PA is supplied. Passage **734***g* connects with a pasage **734***h* which when valve **746** is in central position is closed by the central land of said valve. Passage **734***h* extends through valve **752** and chamber **734***e* to a passage **734***i* which extends to valve chamber **734***a*. A passage **734***j* communicates with valve chamber **734***a* and has therein an acceleration control orifice **734***k*, said passage extending to one end of valve chamber **734***b*. A passage **734***m* extends from valve chamber **734***a* and also has therein an acceleration control orifice **734***n*, said passage extending to the other end of valve chamber **734***b*. Suitable passages **734***o* extend to tank and communicate respectively with valve chambers **734***a*, **734***c* and **734***e*. The conduit **731** communicates with a passage **734***p* which extends to chamber **734***b*. Conduit **730** communicates with a passage **734***q* which extends to valve chamber **734***b*. A short passage **734***r* extends from chamber **734***d* to passage **734***e*. Passages **734***t* and **734***v* extend from valve chamber **734***b* to relief valve chambers **734***c* and **734***d* respectively. Valve **746** has at one end a stop collar **746***a* adapted to egage block **734** and at its other end said valve is operatively connected to a lever **755** of bell crank form, the same being pivoted to block **734**. A slide **756** is operatively engaged with the other arm of lever **755** and carries spaced cam rollers **757** and **758**. Rollers **757** and **758** are adapted respectively to be engaged by cams **760** and **761** splined to and longitudinally movable on shaft **718**, the same having a threaded hub **762** engaged by a threaded portion of shaft **718**.

One side of chain **704** extends in a straight line between sprockets **705** and **706** and this is the side of the chain carrying the hoist pawls **765**. A hoist pawl **765** is secured at its ends to said chain and comprises a spring pressed swinging portion **765***a* which engages the bottom of the powder case in the hoisting operation. Pawl **765** has an inclined surface **765***b* at one side thereof adapted to engage and swing a lever **766** to operate a switch IH3A which will indicate that the pawl is in its upper position. A switch IH2AB is so disposed as to be engaged by clutch lever **721** when the hoist clutch is engaged and will thus indicate such engagement. When the chain **704** moves downwardly with pawl **765** with a round of ammunition in the tube of the hoist, pawl **765** engages the side of the powder case and is pushed inwardly by the same as it moves downwardly. In its lower position pawl **765** operates a switch IH5A1, designated IG5A on the left-hand hoist, which will indicate the position of the pawl. When a round of ammunition is in the lower portion of the hoist tube resting upon plate **702***a* therein, it engages a roller at the top of a lever **771** mounted in the side of the tube, which lever comprises a plate **771***a* adapted to engage the actuating plungers of a switch IH4A, designated IG4A on the left-hand hoist. This switch indicates that the hoist tube is loaded or contains a round of ammunition in position to be moved upward by the hoist.

FIG. 45 shows a round of ammunition in position to be hoisted in each of the hoist tubes. The hoist can operate with both tubes thus loaded or it can operate with a round of ammunition present only in one tube. As shown in said FIG. 45, the pawl **765** of the left-hand hoist tube has just been moved by chain **704** to move a round of ammunition to the cradle. The carrier has then previously transferred a round of ammunition into each hoist tube.

Operation of a hoist cycle

When switches IH4A indicating that there is a round of ammunition in the hoist tube ready to be hoisted, IG1B indicating that the upper hoist shutter is closed, IH5A indicating the pawl **765** is down and extended to the lift the round, IJ9 indicating the pawl **1060** is retracted or down and out of the way of a round entering the cradle, IJ8 indicating that yoke **1005–1** and shaft **1034** are retracted, IJ1A indicating that the cradle is latched to the upper hoist, and switch IJ3A indicating that pawl **1031** is in position to be actuated to retain the projectile, an electrical circuit will be closed and solenoid SH3 will be energized and this will swing lever **738** to the position shown in FIG. 51, thus oscillating lever **736** in a counterclockwise direction moving valve **735** to the position shown. PA can now enter passage **734***g* and will pass to and through flow regulating valve **752** to passage **734***i*, then around valve **735** in chamber **734***a* to passage **734***j*. Thus PA enters chamber **752***b* and flows about valve **752**, as show in FIG. 51, and valve **752** is moved to the left. Valve **752** partially opens tank passage **734***o*. Some of the liquid is by-passed to tank so that liquid under reduced pressure passes upward in passage **734***i*. Spring **753** is set at a certain pressure which will determine the reduced pressure of the fluid. Passage **734***j* contains an acceleration orifice **734***k* which will throttle the fluid so that the hoist will be properly accelerated. PA passes through passage **734***j* to the lower end of chamber **734***b* and moves value **746** upwardly. The central land of valve **746** moves out of alingment with passage **734***h*. PA can now pass through passage **734***h* into chamber **734***b* and out through passage **734***p* to conduit **731** and to the fluid motor **729**. The fluid will return through conduit **730** to passage **734***q*. This passage leads to chamber **734***b*. The fluid will pass around valve **746** into passage **734***v*, around valve **750** to tank passage **734***o*. The passage **734***q* also communicates with the lower end of valve chamber **734***c* and valve **750** will be moved to partially close tank outlet passage **730**. The flow of discharge from motor **729** is thus nicely regulated as desired by valve **750**. The motor **729** is now operated and shaft **728** is operated and shafts **717** and **718** are rotated in opposite directions by the beveled gears **726** and **727**. The left-hand hoist will now be moved to move pawl **765** upwardly to move the round of ammunition upwardly into the cradle and the right-hand hoist will be moved to move pawl **765** downwardly into position for the hoist to receive another round. As shaft **718** rotates, the threaded hub **762** of cams **760** and **761** is moved and said cams are moved so that cam **761** will engage roller **758**. When this occurs, members **756** will be moved to the right, as shown in FIG. 51, and lever **755** will be oscillated and will move valve **746** downwardly to the position shown in FIG. 51.

Fluid from the motor now gradually is cut off by valve **746** closing tank passage **734***v* and the chain **704** stops as the pawls **765** reach their lower and upper positions respectively.

In the next cycle of the hoist, solenoid SG3 will be actuated and lever **738** will be moved to oscillate lever **736** in a clockwise direction and move valve **735** to the right, as shown in FIG. 51. Solenoids SH3 and SG3 are push solenoids. With valve **735** moved to the right, PA can now pass from passage **734***g*, through flow control valve **752**, through passage **734***i*, around valve **735** to passage **734***m*. This passage also contains an acceleration orifice **734***n*. Fuid now passes to the top of valve **746** and said valve is moved downwardly. This again moves the central land of valve **746** out of register with passage **734***h*. The reduced pressure liquid can now pass through passage **734***h* to chamber **734***b* between the upper lands of valve **746** and out through passage **734***q* to conduit **730** and to motor **729** which will now be rotated in a direction opposite to that in the previous cycle. The fluid will return through conduit **731** and will pass through passage **734***p* around valve **746** to passage **734***v*, around valve **751** through passage **734***r* and to tank through passages **734***i* and **734***o*. Passage **734***p* also extends to the top of valve chamber **734***d*. Valve **751** will be moved downwardly and will partially close passage **734***r*, thus decelerating the hoist. Motor **729** as stated will now be driven in the opposite direction to that above described and shafts **717** and **718** will be rotated to move chain **704** so that pawl **765** in the left-hand hoist tube will be moved downwardly and pawl **765** in the right-hand hoist tube will be moved upwardly. As shaft **718** rotates, the hub **762** will be moved to the left, as seen in FIG. 51, and roller **757** and member **756** will be moved to the left by member **760** thus swinging bell crank lever in a counter-clockwise direction and lifting valve **746**. Valve **746** will cut off passage **734***v* and the motor will be stopped as the pawls **765** reach their upper and lower positions respectively. The chains **704** of the hoist are thus moved to reciprocate the pawls **765**. The detent **742** alternately enters the recesses **736***a* to hold lever **736** and valve **735** in the positions to which they are moved by solenoids SH3 and SG3. The upper hoist thus reciprocates and moves the round of ammunition therein to and into the cradle.

THE CRADLE

The round of ammunition including the projectile and powder case are transferred by the upper hoist to a cradle. This cradle comprises an arm **900** (see FIGS. 1 and 52 to 56) which is bored at one end to fit on and be swingable about a journal on the trunnion **12***b* on which the gun and the slide swing when the gun is elevated. The arm **900** thus swings about the axis of the trunnions. There is a cradle with its arm **900** at each side of the mount and the rounds are respectively delivered to the cradles from the upper hoist tubes which are at opposite sides of the central column. As previously stated, the upper hoist moves with the mount proper and is secured to the base ring of the mount proper. The cradle arm **900** carries the cradle **902** which, as shown in FIGS. 52, 60, 61, 62, 68 and 69 comprises a casing of general cylindrical form and having an open end. Said casing comprises a fixed semi-cylindrical ammunition holding portion **902***a*, an upper swingable shutter **902***b* and a lower swingable shutter **902***a***2**. Upper shutter **902***b* is swung open so that the round of ammunition can be ejected into the transfer tray. Lower shutter **902***a***2** is provided to guide and position the projectile while it is in the cradle.

Cradle swinging means

A cradle swinging arm **904** is pivoted at one end on a pivot **899** carried in a bracket **907**, which pivot is carried in a bracket **901** which is bolted to the base ring **14**. (See FIGS. 1 and 1*a*.) The arm **904** at its other end is connected by pivot **906** to the cradle arm **900**. The arm **904** comprises a hydraulic cylinder **904***a* and a plunger **904***b* movable therein, which plunger is moved to extend arm **900** and swing the cradle from a substantially vertical receiving position, as shown in FIG. 1, to a delivery position parallel with the axis of the gun and alongside a transfer tray to which the round is delivered by the cradle. The plunger **904***b* has a head portion **904***c* embracing pivot **906** extending through and concentric with head portion **904***c* and extending through and concentric with lugs **900***a* on the cradle arm **900**. See FIGS. 55 and 56. An arcuate cam **908** is secured to the gun slide adjacent the trunnion **12***b* and is engaged by a roller **910** carried in the bifurcated end of a lever **911** pivoted to lugs **912** carried on the cradle arm **900**. A rod or shaft **914** is secured at one end by a ball joint to lever **911** and extends through the pivot assembly **906** which connects plunger **904***b* and the cradle arm. Plunger **914** is connected by a ball joint to an arm **916** secured to a shaft **917** journaled adjacent one end in a bracket **918** which is carried on the plunger **904***b*. (See FIGS. 54 to 56.) The pivot **906** comprises a bushing **906***b* and a sleeve **906***c* carried in the sides **900***a* of arm **900**. A compression coiled spring **897** is disposed within sleeve **906***c* and engages a flange on said sleeve at one end thereof. At its other end, spring **897** engages a member **906***d* which carries a ball bearing **898** in which rod **914** is journaled. Bearing **898** engages a collar **914***a* on rod **914** and spring **897** thus acts to move arm **911** and hold roller **910** against cam **908**.

Cylinder **904***a* has a bracket **904***d* extending at one side thereof comprising a bearing for a tube **919** and an arm **920** is secured to tube **919** to the end of which is pivoted a valve rod **922***a* of a valve **922** disposed in a valve casing **923** carried on cylinder **904***a*. Tube **919** extends for some distance along cylinder **904***a*, as shown in FIG. 56. Shaft **917** is splined and is slidable in the splined bore of tube **919**.

The plunger or piston **904***b* has an end portion **904***b***1** which fits in the bore of cylinder **904***a* (see FIG. 54), and said portion **904***b***1** slides in said bore when piston **904***b* is projected to swing the cradle to delivery position adjacent the transfer tray. Cylinder **904***a* has a spindle **904***e* secured to its pivoted end, which spindle is disposed in a bore in piston **904***b***1**. As shown in FIG. 54, spindle **904***e* is somewhat tapered toward its free end. Spindle **904***e* has a fluid passage **904***f* extending axially thereof and opening at its free end into the bore of cylinder **904***a*. Passage **904***f* communicates with a passage **899***a* extending axially of pivot **899** and passage **899***a* communicates with a conduit **926** which is connected to a valve chamber **928***a* in a valve block **928**, and continues to a chamber **928***bb* in which is disposed a spring pressed check valve **913** closing passage **926**. Passage **899***a* has an enlargement at one end and a spring pressed check valve **927** is disposed therein. A passage **929** communicates with said enlarged end of passage **899***a* and communicates with the end of the bore of cylinder **904***a*, which end is adjacent pivot **899**. Another conduit and passage **930** extends into pivot **899** and communicates with a passage and conduit **930***a* extending longitudinally in cylinder **904***a* and this passage communicates with a passage **932***a* in a valve block **932** carried on cylinder **904***a*. Passage **932***a* has an enlarged end in which is disposed a spring pressed check valve **933** urged to position to close passage **932***a*. A passage **932***b* extends from said enlarged end of passage **932***a* to a valve chamber **932***c* in which valve **922** is movable. Passage **932***b* also communicates with one end of a valve chamber **932***d* in valve block **932**. A valve **934** is movable in chamber **932***d* and is urged to one end of said chamber by a compression coiled spring **940**. A passage **932***e* extends from valve chamber **932***c* and has spaced branches communicating with valve chamber **932***d*. A passage **932***f* extends from valve chamber **932***d* to and communicates with passage and conduit **930***a*.

Another passage 932*g* extends from passage 932*b* to the bore of cylinder 904*a*.

Conduit and passage 930 also extends to a valve chamber 928*c* in valve block 928 in which is a spring-pressed check valve 915 acting to close passage 930. A passage or conduit 928*d* extends to a valve chamber 928*e* in valve block 928 and is adapted to receive liquid under pressure from an accumulator. Such liquid under accumulator pressure will hereinafter be referred to as PA. Passage 928*d* has a portion communicating with valve chamber 928*e* and also has portions communicating with valve chambers 928*b* and 928*a*. A valve 944 is disposed in valve chamber 928*e* and urged to one end of said chamber by a compression coiled spring 945. A valve 946 is disposed in valve chamber 928*b* and is urged toward one end of said chamber by a compression coiled spring 948. A valve 950 is disposed in valve chamber 928*a* and is urged to one end of said chamber by a compression coiled spring 951. A passage 928*f* communicates with valve chamber 928*e*, with valve chamber 928*b* and with valve chamber 928*a* and will be connected to tank. Another passage or conduit 952 communicates with valve chamber 928*b* and with a valve chamber 954*a* in a valve block 954. (See FIG. 57.) A passage and conduit 954*b* extending to tank also communicates with valve chamber 954*a*. Another passage 954*c* to tank communicates at spaced points with valve chamber 954*a* and with a valve chamber 954*d* in valve block 954. A reduced pressure passage or conduit 956 communicates at spaced points with valve chamber 928*e* and extends to valve passage 954*a*. Another reduced pressure passage or conduit 958 extends from valve chamber 928*b* to valve chamber 928*a* and thence to a valve chamber 960*a* in a valve casing 960. A cylindrical member 946*a* fits in and is movable in chamber 928*e* above valve 946. Member 946*a* is provided so that valve 946 can be moved downward by fluid from passage 952. Another reduced pressure passage 959 extends from valve chamber 954*a* to valve chamber 960*a*. A passage 928*g* to tank communicates with valve chambers 928*b* and 928*a*.

A valve 962 and a plunger 963 are movable respectively in valve chambers 954*a* and 954*d*. A compression coiled spring 953 engages plunger 963 tending to move the same upward, as shown in FIG. 57. Valve 962 and plunger 963 are respectively connected to opposite ends of a lever 964 carried on a shaft 965 having connected thereto a lever 966 to the opposite ends of which are pivotally connected the plungers 968 and 969 of solenoids SJ1 and SJ4 respectively. Solenoids SJ4 and SJ1 are of the push type. Lever 966 has portions 966*a* disposed to engage the operating plungers of switches IJ104A and IJ101AB.

Cradle to hoist latch

A valve 970 is movable in valve chamber 960*a* having a rod which is pivotally connected to a latch member 972. A compression coiled spring 971 engages the bottom of valve 970 at one end and the bottom of valve chamber 960*a* at its other end and thus tends to move valve 970 upwardly, as shown in FIG. 58. Latch member 972 is pivotally connected to a pivot 973 carried on the end of valve casing 960. A passage 960*b* leads from valve chamber 960*a* at the lower portion thereof to tank. The latch 972 forms part of the latch mechanism for latching the cradle to the upper hoist. A bracket 974 is connected to the cradle arm 900 on which is journaled a roller 975. (See FIG. 52.) Roller 975 cooperates with the latch member 972 to latch the cradle to the upper hoist. An arm 986 is pivoted to bracket 974 about a pivot 967. (See FIG. 59.) Arm 986 has an adjustable stud 986*a* therein adapted to engage the actuating plunger of a switch IJ1A when the roller 975 is in latched position. Arm 986 is urged to its lower position and away from switch IJ1 by a compression coiled spring 987 which acts against an extension 986*a* of arm 986. Operation of latch 972 and switch IJ1A is later described.

Cradle to slide buffer

Carried on the side of the cradle arm 900 is a roller 977. (See FIG. 52.) A buffer casing 978 shown in FIGS. 52 and 65 is carried on the gun slide. Casing 978 has a chamber 978*a* therein in which is movable a piston 979 having a rod 979*a* projecting through the end of casing 978. Piston 979 has a substantially cylindrical opening in its end into which projects a tapered lug 978*b* forming part of casing 978. Movement of piston 979 is resisted by a compression coiled spring 980. A passage 978*c* extends from chamber 978*a* to a chamber 978*d*. A piston 982 is movable in chamber 978*d* and movement thereof is resisted by a compression coiled spring 983. The piston 982 moving within its chamber 978*d*, provides expansion space for excess oil. As the cradle approaches the transfer tray, roller 977 engages lever 984 and said lever engages valve rod 979*a*. Rod 979*a* is moved inwardly thus moving piston 979 over lug 978*b* thereby trapping oil and providing snubbing action. A lever 984 of general triangular form is pivoted adjacent one corner thereof on a pivot 984*b* carried on the gun slide. Lever 984 has a portion 984*a* adapted to engage the rod 979*a*. One end of lever 984 is adapted to be engaged by roller 977 as the cradle comes into delivery position adjacent the transfer tray.

Cradle to slide latch

As stated, when the cradle swings upward to a position alongside the transfer tray, it is latched to the slide. For this purpose cradle arm 900 has secured thereto a bracket 900*j* in which is journaled a roller 901. (See FIG. 75.) A latch lever 903 which is in the form of a bell crank lever is pivoted to the gun slide and the same has at its free end a semi-cylindrical recess adapted to engage roller 901. The other end of lever 903 is pivotally connected to a rod 905 which is normally urged to move lever 903 to latching position by a compression coiled spring 909 engaging a head on rod 905 at one end and at its other end engaging a bracket 913 secured to the gun slide. Lever 903 has a projecting portion 903*a* adapted to engage the roller carried on the actuating arm 923 of a switch IJ4 (IK4 on other cradle). Switch IJ4 will be opened by portion 903 and will indicate that the cradle is in latched position. Rod 905 has an elongated slot in its lower end in which moves a pin 924 connected to the rod of a piston or valve 921 movable in a chamber 925*a* of a valve block 925 secured to the gun slide. Rod 905 has an arm at one side thereof which is adapted to engage the actuating plunger of a switch IJ6 when the latch is in unlatched position. Switch IJ6 thus indicates that the cradle is unlatched from the slide.

Another valve block 931 is provided supported on the gun slide which has therein a valve chamber 931*a*. A valve 935 is movable in chamber 931*a* and is connected at one end to a solenoid SJ3. At its other end, valve 935 is connected to a solenoid SJ2. A switch IJ103 is adapted to be actuated by valve 935 and solenoid SJ3 and a switch IJ102 is adapted to be operated by valve 935 and solenoid SJ2. Switches IJ102 and IJ103 respectively indicate when solenoids SJ2 and SJ3 have completed their strokes. Passages 931*b* and 931*c* communicate with the opposite ends of valve chamber 931*a*. Passages or conduits 931*d* and 931*e* extend from spaced portions of valve chamber 931*a* to the opposite ends respectively of valve chamber 925*a*. PA is supplied to conduit 931*c* and PS is supplied to conduit 931*b* and 931*e*.

Round transferring mechanism

As stated, the round of ammunition is transferred from the cradle to the transfer tray.

A plurality of bearing brackets **1000** are secured to the cradle arm **900** in which is journaled a hollow shaft **1002**. (See FIGS. 52, 60 and 68.) Shaft **1002** is oscillatable in brackets **1000** and carries pairs of spaced arms **1002***a*. Disposed between and pivoted to each pair of arms **1002***a* by pivot bolts **1004** are yokes **1005**. Each yoke **1005** has spaced arms with a semi-circular recess therebetween, the ends of said arms being substantially 180 degrees apart. Yokes **1005** are each also pivoted at the end opposite said arms by a pivot **1006** to a link **1007** which is in turn pivoted to a bracket **1008** secured to the cradle arm **900**. Yokes **1005** form ejectors for moving the round of ammunition into the transfer tray. A valve block **1010** (see FIG. 66) is carried on cradle arm **900** having a valve chamber **1010***a* therein in which is movable a valve **1012** having a valve rod **1012***a* pivotally connected by an adjustable link **1013** to an arm **1002***b* which is integral with shaft **1002**. Valve block **1010** also has therein a valve chamber **1010***b* in which is movable a valve **1014**. Valve **1014** has a rod **1014***a* extending through one end of valve casing **1010**, which rod is constructed and arranged to engage one end of a bell crank lever **1015** swingable on a pivot **1016** carried in a bearing **1017** secured to one end of valve block **1010**. Lever **1015** carries at its other end a roller **1015***a* which, as shown in FIGS. 66 and 69, is adapted to seat in a recess **1002***c* in a segmental plate **1002***d* carried on shaft **1002**. When roller **1015***a* is in recess **1002***c* the ejectors **1005** are latched in retracted position. Valve block **1010** has a passage **1010***c* extending from one end of chamber **1010***a*, as shown in FIG. 66, to an intermediate portion of chamber **1010***b*. A passage **1010***d* at the left of passage **1010***c* communicates with chamber **1010***b* adjacent one end thereof. A passage **1010***e* extends from one end of chamber **1010***a* to an intermediate portion of chamber **1010***b* and a passage **1010***f* extends from adjacent one end of chamber **1010***a* to chamber **1010***b* adjacent one end of the latter. A valve block **1020** is provided having therein a valve chamber **1020***a* in which is movable a valve **1021** having a rod **1021***a* pivotally connected at one side of block **1020** to an arm **1022** connected to a shaft **1023** to which is also connected a lever **1024** having oppositely extending arms at each side of shaft **1023** and pivotally connected to the operating plungers **1026** and **1027** of solenoids SJ6 and SJ5 respectively. Lever **1024** has portions thereon adapted to engage the actuating plungers of switches IJ106 and IJ105 respectively. Switches IJ105 and IJ106 thus respectively indicate that solenoids SJ5 and SJ6 have completed their strokes.

A passage and conduit **1020***b* carrying PA communicates with valve chamber **1020***a* and a passage **1020***c* extends from chamber **1020***a* to a chamber **1020***e*. Said latter chamber has at one end and at one side of passage **1020***c* a cup-shaped member **1028**. Disposed at the opposite side of passages **1020***c* in chamber **1020***e* is an open ended shell **1030** with its open end adjacent passage **1020***c*. Member **1030** has an opening at its upper end communicating with the upper portion of valve chamber **1020***e*. A passage and conduit **1020***h* extends from the upper end of valve chamber **1020***e* to spaced points in chamber **1010***b*. A conduit and passage **1020***d* extends from spaced points in valve chamber **1020***a* to valve chamber **1010***b*. Another passage **1020***i* extends from one end of chamber **1020***a* to tank. Disposed between the end of member **1030** and the end of member **1028** is a compression coiled spring **1032**.

Slidable within the hollow shaft **1002** is a splined hollow shaft **1034** having at its outer end a portion **1034***a* which has projecting therefrom at its top a bifurcated portion **1034***b*. (See FIGS. 52, 60 and 64.) Pivoted between the bifurcations of member **1034***b* on a pivot bolt **1038** is another yoke or ejector **1005–1** similar in shape to the yokes **1005** and similarly pivoted at its lower end to a link **1007** which is connected to a sliding pivot. The sliding pivot **1007***a* is carried along as the splined hollow shaft **1034** is pulled out of the hollow shaft **1002** by the nose of the projectile. Shaft **1034** is provided with a splined bore in which fits a guide shaft **1040** on which shaft **1034** slides. Shaft **1040** is supported on its outer end on a bracket **1041** secured to the cradle arm **900**. Shaft **1040** is provided with a bore and a conduit and passage **1042***a* connects with said bore through a conduit **1042**. Conduit **1042** is adapted to receive PA. Shaft **1034** has secured to its rear end and disposed axially thereof a plunger or shaft **1044** which extends into the bore of shaft **1040**. Shaft **1044** is provided with a bore at its forward end in which is slidable a check valve **1045** having a valve head engaging a seat **1044***a* which closes a bore **1044***b* extending through the end of shaft **1044**. A compression coiled spring **1047** acts to hold valve **1045** against said seat. Passages **1044***c* extend from the rear of the chamber in which valve **1045** is disposed to the outer side of shaft **1044** and they communicate with the bore of shaft **1040**. Shaft **1044** is provided with a rearwardly extending taper adjacent its outer end. A small lever **1035** (see FIG. 60) is pivoted intermediate its end to a portion of the cradle and has an upper end arranged to be engaged by yoke **1005–1** when said yoke is fully retracted. Lever **1035** is swung by said yoke and its lower end is disposed to engage the actuating plunger of a switch IJ8. (See FIG. 60.)

The shutter **902***b* of the cradle casing has ribs **902***b***3** integral therewith and spaced longitudinally thereof, pivoted by pivots **1050** to lugs **902***b***4** on the holder portion of the cradle casing. The shutter **902***b* is swingable about the axes of the pivots **1050** which are in axial alignment. A rod **1048** extends between two of the lugs **902***b***4** and carries thereon a torsion spring **1047** having one end secured to shutter **902***b* and its other end secured to the other portion of the cradle casing. Spring **1047** tends to swing the shutter **902***b* to closed position. One of the ribs **902***b***3** is extended and has its end pivotally secured to the upper end of a link **1051**. (See FIGS. 60 and 69.) Link **1051** has a threaded bore in which is secured an adjustable stud **1051***b*. Link **1051** is pivotally secured at its lower end to the upper end of bell crank lever **1015**. A tensile coiled spring **1054** is connected at one end to lever **1051** and at its other end is connected to a lug **902***b***5** on portion **902***a* of the cradle casing.

Shaft **1016** (see FIG. 62) has secured thereto an arm **1011** which is connected by a link **1013** to a member or yoke **1025** which embraces and is oscillatable on shaft **1002**. Member **1025** is connected by another link **1026** to the lower shutter **902***a***2**. Said lower shutter swings about a pair of pivots **1027** carried in lugs on the fixed or holding portion of the cradle casing. An arm **1029** is connected to shaft **1016** and positioned to engage the actuating plunger of a switch IJ5. Shaft **1016** is turned counter-clockwise in the ejecting operation and switch IJ5 indicates that the ejectors **1005** are retracted or extended. The lower shutter **902***a***2**, as shown in FIG. 62, extends for only part of the length of the cradle casing. It will be seen that the lower shutter will be operated when shaft **1016** is oscillated, which operation will be later described.

The cradle casing at its receiving end is equipped with a pawl **1031** swingable about a pivot **1032** carried in a lug on the holding portion of the cradle. (See FIGS. 52 and 60.) Pawl **1031** is urged to operative position by a compression coiled spring **1036** disposed between one end thereof and the cradle casing. Pawl **1031** has a beveled surface **1031***a* adapted to be engaged by the projectile and powder case as they move into the cradle. While pawl **1031** is described as shown in the schematic FIG. 52, in practice pawl **1031** extends downwardly through the top of the cradle. When pawl **1031** is in the position shown in FIG. 60, a switch IJ3B is closed which indicates the position of said pawl. As shown in FIG. 60, pawl **1031** oscillates a lever **1031***a* which engages the arm IJ3B, said lever being moved in one direction by spring **1031***b*.

A lever **1037** is pivoted on a switch housing IJ**10** supported on the cradle casing, said lever extending through an opening in said casing and carrying a roller **1039** adapted to be engaged by the projectile when the same moves into the cradle. Switch IJ**10** thus indicates that there is a round of ammunition in the cradle.

At times a shorter round of ammunition than that indicated in the drawings is used. To handle this shorter ammunition a mechanism shown in FIGS. 52, 53 and 67 is used. A pawl **1060** is pivotally connected by a pivot **1062** to the end of a valve rod **1063***a* moved by a valve **1063** which is disposed in a valve chamber **1065***a* of a valve casing **1065**. Valve rod **1063***a* extends from the end of valve block **1065** opposite pawl **1060**. This end contacts a bell crank lever **1066** pivoted to the cradle arm and which is positioned to actuate a switch IJ**2**. Switch IJ**2** thus indicates that valve rod **1063***a* is extended and that powl **1060** is in the end of the cradle. Valve rod **1063***a* also carries an arm **1063***b* positioned to engage the actuating plunger of a switch IJ**9** carried on valve block **1065**. Switch IJ**9** thus indicates when pawl **1060** and valve rod **1063***a* are retracted with pawl **1060** out of the cradle. The pivot **1062** at the end of valve rod **1063***a* carries rollers **1061***a* which are movable in a slot or groove **1067***a* in a block **1067** secured to the cradle arm, which groove has a curve at one end forming a right angle turn. Similar rollers **1061***a* are also carried on a pin **1061**, secured in a pawl **1060**, which rollers also roll in groove **1067***a*. Valve casing **1065** has therein another valve chamber **1065***b* in which is movable a valve **1068**. Valve **1068**, as shown in FIG. 67, is moved to the left by a compression coiled spring **1070** which engages valve casing **1065** at one end and a portion **1068***a* of valve **1068** at its other end. A passage **1065***c* extends from the left-hand end of valve chamber **1065***a* to adjacent the right-hand end of valve chamber **1065***b*. Said passage **1065***c* is shown as having a restriction therein. A passage **1065***d* extends from adjacent the left-hand end of valve chamber **1065***a* to an intermediate portion in valve chamber **1065***b*. Passage **1065***d* has a restriction therein. Another passage **1065***e* extends from the right-hand end of valve chamber **1065***e* to adjacent the right-hand end of valve chamber **1065***b*. A passage and conduit **1065***f* extends from valve chamber **1065***b* to passage and conduit **1020***f*, shown in FIGS. 66 and 67. Another passage and conduit **1065***g* extends from valve chamber **1065***b* and connects with passage and conduit **1020***g*, shown in FIGS. 66 and 67. Passage **1065***g* also communicates with conduit **1042** shown in FIG. 52. Valve **1068** projects from valve casing **1065** and has a head portion **1068***b* at its end having a beveled front portion and an annular groove in the rear thereof which is of triangular shape in cross section. Valve **1068** is adapted to be connected by a pawl **1072** to a member **1073**. Pawl **1072** has a beveled end adapted to seat in said annular groove and said pawl is pivoted by a pivot **1075** to member **1073** and is urged to position to engage valve rod **1068** by a compression coiled spring **1077**. Member **1073** is connected to one end of a lever **1078** pivoted intermediate its ends by a pivot **1079** to a portion of the cradle arm **900** and said lever has journalled thereon at its other end a roller **1080**. Lever **1078** is urged by a coiled torsion spring **1081** carried on pivot **1079** to hold roller **1080** against the cradle guide member **992**. A cam plate **1082** is secured to said cradle guide member **992** adjacent its lower end and said plate has an open-ended slot therein in which roller **1080** is adapted to move, said slot having cam surfaces **1082***a* adjacent its open end.

A rod **1084** is slidable in the cradle arm **900** and is urged to one position by a compression coiled spring **1085**. (See FIG. 61.) Rod **1084** is positioned to be engaged at one end by an arm **1086** secured to shaft **1002**. Rod **1084** at its other end is positioned to engage and release pawl **1072** against the resistance of spring **1077**.

Transfer of round from upper hoist to cradle

In operation the round of ammunition comprising the projectile and powder case are delivered to the cradle by the upper hoist when the cradle is in vertical alignment with the upper hoist, as indicated in FIG. 1. The round is moved into the casing of the cradle by the upper hoist and through the recesses in the yokes **1005**, and the ogive of the projectile engages the arms of the forward yoke **1005–1**. Yoke **1005–1** is moved by the projectile and this moves portion **1034***b* and member **1034** is moved outwardly on member **1040**. PA is applied constantly through conduit **1042** and into member **1040** and member **1040** is moved against this pressure. As spindle **1044** starts to move with member **1034**, its forward portion moves in the bore of member **1040** and acts as a piston causing reduced pressure in the rear thereof. This unseats check valve **1045** and the liquid forwardly of member **1044**, passes through passage **1044***b* and out through radial passage **1044***c* to the rear of the forward portion of member **1044**. Member **1034** moves out until the round of ammunition has completely moved into the cradle. The movement of member **1034** against the PA acts to decelerate its movement and the upper hoist is also decelerated by other means as it nears the upper end of its movement. When the round is moved completely into the cradle, pawl **1031** is moved into place by its spring **1036** and will prevent movement of the powder case, and thus of the round out of the cradle. When the round is transferred to the transfer tray, as will be later described, the accumulator pressure returns member **1034** and **1044** to their original positions. As member **1034** approaches the end of its inward movement the tapered portion of member **1044** at its forward end traps some liquid in the small bore at the end of member **1040** and this retards the movement of member **1034** so that said movement is brought gently to a stop when fully retracted. As shaft **1034** moves into shaft **1002** and yoke **1005–1** is retracted, the latter will engage the top of lever **1035** and swing the same to operate switch IJ**8**. Switch IJ**8** thus indicates that the shaft **1034** and yoke **1005–1** are fully retracted.

Movement of cradle from upper hoist to transfer tray

When the various elements on the hoist and carrier in the hydraulic system are posititoned so that an upward cycle of the cradle, assuming the right-hand cradle, is ready to be made, and switches IJ**10** indicating that the cradle contains a round of ammunititon, IK**101**B of the left-hand cradle corresponding to IJ**101**B of the right cradle which will prevent the left cradle from being raised as said cradles operates alternately, switch IK**101**B being opened, IK4A which will indicate that the left cradle is unlatched from the slide, IJ3B indicating that pawl **1031** is in operative posititon, and IJ4B indicating that the cradle is not latched to the slide, are operated, an electrical circuit is closed and the solenoid SJ**1** is energized. This oscillates shaft **965** and lever **964** to move valve **962** to the position shown in FIG. 57. Valve **944** in valve casing **928** is a pressure reducing valve and continually reduces the PA coming through passages **928***d* to a lower pressure of approximately 500 pounds, hereinafter referred to as PS. As shown in FIG. 58 the upper land of valve **944** is blocking PA passage **928***d*. If fluid is called for in conduit **956** the pressure above valve **944** will drop and spring **945** will raise valve **944** permitting fluid to pass to conduit **956**. Spring **945** is balanced at 500 pounds. Should the pressure in conduit **956** use above 500 pounds, it will move valve **944** downwardly and PA will be shut off. A pressure of 500 pounds is thus maintained in conduit **956**. With valve **962** in the position shown, PS can pass from chamber **928***e* through passage and conduit **956** to chamber **954***a* in block **954**. This pressure then passes through conduit and passage **959** to chamber **960***a* in member **960**. This depresses valve **970**

against the pressure of spring **971** swinging latch **972** downward and releasing the cradle from the upper hoist. The reduced pressure passes from chamber **960***a* through conduit and passage **958** to the top of chamber **928***a* in chamber **928** and depresses valve **950** against the pressure of its spring **951**. This closes passage **928***f* from chamber **928***b* to tank. PA now passes from passage **928***d* into valve chamber **928***a* between the lands of valve **950** to and through passage or conduit **926**. Fluid now passes through spindle **904***e* (see FIG. 54) and unseats check valve **927** and passes to the end of the bore in cylinder **904***a*. Piston **904***b* is now projected from the end of cylinder **904***a* and swings the carrier arm **900** upwardly to move the cradle to delivery position. As the cradle approaches its delivery posititon, the roller **910** engages cam **908** and swings lever **911**. (See FIGS. 54 and 55). This through plunger link **914** swings the arm **916** and rotates shaft **917**. This oscillates tube **919** and swings arm **920** to move valve **922** in chamber **932***c*. As piston **904***b* is moved, fluid in cylinder **904***a* is forced through passage **932***g* into passage **932***b* and into passage **932***e*. As valve **922** is moved, it partially closes the end of passage **932***e* giving a retarding effect to piston **904***b*. The fluid passing into chamber **932***d* moves valve **934** against the pressure of spring **940** which also retards the movement of piston **904***b*. As valve **934** is moved, it will also restrict the opening of passage **930***e* and further retard movement of piston **904***b*. The valves **922** and **934** are thus decelerator valves to decelerate the movement of the cradle as it approaches delivery position. As the cradle comes close to delivery position, roller **977** engages lever **984** and the portion **984***a* of the latter engages rod **979***a* and movement of the cradle is thus resisted by the snubber comprising casing **978**. It will be seen that when the piston **979** is moved inwardly (see FIG. 65), spring **980** will be compressed and liquid will be forced through passage **978***c* to chamber **978***d* which will move piston **982** against the pressure of spring **983**. As piston **979** approaches its inner position, the taper of lug **978***b* traps some liquid in piston **979** thus resisting movement thereof. Piston **979** and associated parts thus form a buffer so that cradle **982** is further decelerated as it approaches delivery position. The cradle is thus brought gradually to a stop as it reaches its delivery position adjacent the transfer tray. Valve **915** and **913** shown in FIG. 58 are relief valves. If the cradle is swung upwardly to latched posititon certain of the valve chambers and passages must be vented as described. Should the gun be lowered before this venting took place excessive pressure could be generated in passages **926** and **930**. Such pressure will be relieved to PA through valve **913** and **915**. It will be noted that the cradle swings different distances in different cycles depending on the position of the gun in elevation.

When the cradle is to be swung upward to the transfer tray and the above mentioned switches operated, solenoid SJ2 is also actuated and valve **935** is moved to the position shown in FIG. 75. PS is now delivered to both ends of valve chamber **925***a* and valve **921** is moved to the position shown in FIG. 75. Spring **909** now holds arm **903** in latching position and as the cradle arm reaches its posititon alongside the transfer tray, roller **901** engages lever **903** and moves into the recess in the end thereof, as shown in FIG. 74. The cradle is now latched in posititon alongside the transfer tray.

Transfer of round to transfer tray

When the cradle has been moved to its upper or delivery position and is latched to the slide alongside of the transfer tray and all parts are in proper position, and switches IJ1, indicating that there is a round of ammunition in the cradle, IJ2 indicating that pawl **1060** is in operative position to position the round in the cradle, IJ4 indicating that the cradle is latched to the slide, IL102A indicating that the fuse pot has been retracted, 1O3A indicating that the upper shutter of the transfer tray is open, IO9 indicating that the lower shutter on the transfer tray is open or in other words in inoperative position, IRA indicating that the rammer is twelve inches or more away from its forward position, RO2–2AB on the Gun Captain's panel (not shown) indicating that the transfer tray is in its upper position, RO1–2HA in the Gun Captain's panel (not shown) and **102**A both indicating that the transfer tray is not loaded, have been operated, an electrical circuit is closed and solenoid SJ6 (FIGS. 66–68) is energized and lever **1024** has its right-hand end moved downwardly, as shown in FIG. 66, so that arm **1022** is rotated in a clockwise direction and valve **1021** is moved inwardly. PA can now pass from passage and conduit **1020***b* around valve **1021** to passage **1020***d*, to the left-hand end of chamber **1010***b* and then through the central passage in valve **1014** to the end of said valve chamber **1010***b*. This will move valve **1014** to the right. When valve **1014** moves to the right, rod **1014***a* engages lever **1015** and swings the same in a counter-clockwise direction, as shown in FIG. 66. This swings roller **1015***a* out of recess **1002***c* and unlatches the shutter **902***b*. Movement of arm **1015** rotates shaft **1016** in a counter-clockwise direction, as seen in FIG. 66, and this through arm **1011** and link **1013** will swing lower shutter to open position. The projectile can then be ejected. When valve **1014** moves to the right, PA can pass through passage **1020***d* around said valve into passage **1010***e*, into chamber **1010***a* to the left end of valve **1012**, and valve **1012** is moved to the right. When valve **1012** moves to the right, its rod **1012***a* pushes on link **1013** which in turn swings arm **1002***b* in a clockwise direction, as seen in FIG. 66. Movement of arm **1002***b* swings member **1002** and this in turn swings arm **1002***a* in a clockwise direction, as shown in FIG. 68. When lever **1015** was swung as described, it in turn moved link **1051** downwardly and the shutter **902***b* was swung to the open position shown in dotted lines in FIG. 68. Swinging of arms **1002***a* swings the yokes **1005** and **1005–1** in a clockwise direction to the dotted line position shown in FIG. 68. The round is thus moved into axial alignment with the transfer tray, as shown in FIG. 68, and will be engaged by a clamp in said tray to be later described.

When the round has thus been delivered to the transfer tray and switch IO4A is closed, indicating that the round is clamped in the transfer tray, an electrical circuit is closed and solenoid SJ5 is energized and lever **1024** has its left-hand end, as shown in FIG. 66, moved downwardly, and arm **1022** is oscillated in a counter clockwise direction, moving valve **1021** to its left-hand position. PA can now pass from passage **1020***b* around valve **1021**, through passage **1020***c*, through conduit and passage **1020***h* and through branch passage **1010***g* to chamber **1010***b*. Valve **1014** is moved to its left-hand position and lever **1015** is moved to the position shown in FIG. 66 by springs **1047** and **1054**. Said lever **1015** is swung in a counter-clockwise direction, as shown in FIGS. 63 and 69. Springs **1047** and **1054** move shutter **902***b* to closed position. When valve **1014** is moved to the left, PA can pass through passage **1020***h*, around valve **1014** and through passage **1010***c* to chamber **1010***a* at the right of valve **1012** which will moved to its left-hand position, as shown. This swings arm **1002***b* in a counter-clockwise direction, as shown in FIG. 66, thus swinging shaft **1002** and arms **1002***a*, which in turn swing the yokes **1005** and **1005–1** to normal or retracted position, as shown in full line in FIG. 68. When arms **1002***a*, **1002***b*, **1002***d*, shaft **1002**, and yokes **1005** and **1005–1** are returned to normal retracted position, roller **1060**, carried on bell crank **1015**, will fall into recess **1002***c* locking the above moving parts in retracted position. When shaft **1016** was moved, arm **1011** was swung in a clockwise direction and links **1013**, member **1025** and link **1026** were moved upwardly and lower shutter **902***a***2** was moved to closed position. As shown in FIG. 63, when said lower shutter is in closed position, links **1013**, **1026** and arm **1011** are substantially in a straight line so that they form

a straightened toggle and lock lower shutter **902***a***2** in closed position. All parts of the cradle have now been returned to normal position and another cycle to swing the cradle to receiving position in alignment with the upper hoist may be initiated.

Cradle movement to upper hoist

When the cradle arm is to be moved downward to align with the upper hoist, switches IJ10 indicating that the cradle is empty, IJ5 indicating that the round ejectors are retracted and IJ1 indicating that the other cradle is unlatched from the upper hoist, have been operated and they close a circuit and energize solenoid SJ3. Valve **935** will now be moved upwardly, as shown in FIG. 75. PS will then be cut off from the lower end of piston **921** and the pressure through conduit **931***e* will force valve **921** downward and pin **915** will pull rod **905** downwardly thus swinging lever **903** against the resistance of spring **909**, moving lever **903** to unlatching position and operating switch IJ6. The cradle arm **900** is now unlatched and is free to be swung to the upper hoist. Switch IJ6 indicating that the cradle is not latched to the slide, closes an electrical circuit and solenoid SJ4 will be energized. This will oscillate shaft **965** and lever **964** and will move valve **962** downward, as shown in FIG. 57. This will cut off conduit and passage **956** and passage **959** is vented through passage **954***c* so that pressure in chamber **960***a* will be relieved and spring **971** will move latching member **972** to its upper position.

When valve **970** is thus moved upward, passages **958** and **960***b* are connected around valve **970** and pressure in chamber **928***a* above valve **950** is relieved to tank. Valve **950** is then raised by spring **951**. This opens the tank passage **928***f*. PA can now go through passage **928***d* and move valve **946** downward. Spring **953** disposed about plunger **963** acts to move said plunger and lever **954** to neutral position when solenoid SJ1 is deenergized.

When valve **950** moved upward, the pressure line to conduit and passage **926** around said valve was closed. PA from passage **928***d* can now pass around valve **946** to conduit and passage **930** and to passage **930***a* in cylinder **904***a*. This PA goes through passage **932***a* and unseats check valve **933**. PA now is applied through passage **932***g* and to the bore of cylinder **904***a*. Piston **904***b* is thus moved into cylinder **904***a* and the liquid ahead of piston **904***b* passes out around spindle **904***e* until piston **904***b* approaches its innermost position when some liquid is trapped by the tapered form of spindle **904***e* and this decelerates said piston. Movement of piston **904***b* into cylinder **904***a* swings cradle arm **900** and the cradle is swung down to the upper hoist. The liquid passes through passage **926** in spindle **904***e* and returns through passage **899***a* and passage **926**. The piston area of piston **904***b* effecting outward movement thereof is substantially twice the area effecting inward movement thereof. PA is maintained on both ends of piston **904***b*. It will thus be seen that the valves **946** and **950** are direction valves determining the upward or lower movement of the cradle.

Cradle latching to hoist

When cradle arm **900** swings downward to move the cradle to the upper hoist, roller **975** will engage the top curved surface of latch **972** and swing said latch downwardly about its pivot **973**. When roller **975** passes the end of latch **972**, said latch will spring up in the rear of said roller and said cradle arm and cradle will be latched to the lower hoist. Cradle arm **900**, as shown in FIGS. 53 and 70, swings about an axis quite a distance above latch **972** so that it is moving in an approximately horizontal arc. Roller **975** thus substantially engages the free end of latch **972**. When latchc **972** is moved upwardly by spring **971**, it engages lever **986** and switch IJ1A is actuated. Switch IJ1A thus indicates that the cradle is latched to the upper hoist.

As the cradle and cradle arm **900** are moved upward to delivery position and then moved downwardly, the same are guided by an arcuate guide **992**. This guide is in the form of a bar of general rectangular shape in cross section and the same is secured to a standard **993** by bolts **995** and said standard is secured to the base ring **14** of the mount. A brace member **994** extends from standard **993** to the trunnion frame. A bracket **996** is secured to the cradle arm **900** by bolts **999** and has secured therein spaced bearing studs **997** (see FIG. 72). Rollers **998** are mounted on studs **997** on needle free end of latch **972**. When latch **972** is moved upguide **992**. The cradle arm is thus held from any movement transversely of the guide **992** as it swings to receiving and delivery position. The cradle thus receives the round comprising the powder case and the projectile from the upper hoist. The projectile is properly held in the cradle by the lower shutter **902***a***2**. The cradle is then swung up to and latched to the slide alongside the transfer tray. The round is then transferred to the transfer tray and the cradle swung down to and latched to the upper hoist.

THE TRANSFER TRAYS

As previously described, when the cradle is moved upwardly it comes into position alongside the transfer tray and is temporarily latched in this position. The round of ammunition is then transferred from the cradle to the transfer tray. There is a transfer tray for each cradle and these are disposed at opposite sides of the gun substantially at the top of the tail gate portion of the slide **12**. Each transfer tray comprises an elongated casing **1100** of general cylindrical form. (See FIG. 76.) Casing **1100** is mounted upon and swings with an arm **1104** pivoted on a shaft **1110** mounted in spaced lugs **1109** on the gun slide **12**. Said casing includes a rigid central portion and a lower pivoted shutter **1100***a*. (See FIGS. 77–84.) Shutter **1100***a* is pivoted for swinging movement and secured to a plurality of shafts **1101** spaced longitudinally of said casing which are oscillatable in lugs **1100***g* on casing **1100**. Shutter **1100***a* has pairs of spaced lugs **1100***g***1** through which said shafts **1101** respectively pass. Shutters **1100***a* are normally urged to open position, as shown in FIG. 76, by coiled torsion springs **1105** which surround shafts **1101** respectively.

Each tray **1100** also has an upper pivoted swinging shutter **1100***b* which is mounted to swing about the axes of a plurality of shafts **1107** spaced longitudinally of said section. Section **1100***b* is secured to said shafts which are oscillatable in pairs of lugs **1100***h* spaced longitudinally of said casing and secured thereto. Shafts **1107** pass through pairs of lugs **1100***ha* on shutter **1100***b*. Shutter **1100***b* is normally urged to open position, as shown in FIG. 76, by a plurality of coiled torsion springs **1108** which respectively surround shafts **1107**. The swinging shutter **1100***b* comprises an arm **1100***c* to which is pivotally connected one end of a chain **1111** which extends around the outer side of the tray and is pivotally connected at its other end to an arm **1112**. (See FIGS. 78 and 84.) Chain **1111** is preferably provided with rollers **1114** at its link pivots which roll on the outer side of tray **1100**. The arm **1112** is pivotally connected at one end to one of the shafts **1101**. Chain **1111** is connected intermediate the ends of arm **1112** and the other end of said arm is pivotally connected to a link **1117**. Link **1117** has an elongated slot **1117***a* adjacent its end in which a pin **1118** carried on arm **1112** is disposed and movable. Link **1117** is pivotally connected at its other end to one portion of a double-armed lever **1120** which is pivoted on a shaft **1121** carried in a lug projecting from arm **1104**. The end of one of the arms of lever **1120** carries a cam roller **1123** which is disposed to engage a cam surface **1124***a* on one side of a cam **1124** carried on one of the bearings **1109**. The end of the other arm of lever **1120** carries a roller **1123***a* adapted to engage the other side of arm **1124**. Roller **1123***a* is provided to control the movement of lever **1120** so that it will not swing too freely.

The shutter **1100***a* has a lug **1100***d* thereon (see FIG. 77), to which is secured an arm **1126** which at its outer end carries a pin **1127** disposed in an elongated open-ended slot **1128***a* in one end of a link **1128**, the other end of which is pivotally connected to a short arm **1131** swingable with a shaft **1132** which is disposed intermediate the ends of a lever **1134** and forms the fulcrum of said lever. One end of lever **1134** is pivotally connected through link **1133** to a lug on a round-clamping member **1136**. Member **1136** is of curved form following generally the curvature of the tray and is secured at one end on an oscillatable shaft **1137** journaled in member **1104**. There are several of the members **1136** spaced longitudinally of tray **1100**. The other end of lever **1134** is pivotally connected to a link **1138** which is in turn pivotally connected to a rod **1140** of a piston valve **1141** disposed in a chamber **1142***a* of a valve block **1142** supported on arm **1104**. A passage and conduit **1142***b* extends from chamber **1142***a* to a portion of arm **1104** and axially of the pivot shaft **1110** thereof and then to a valve chamber **1144***a* formed in a valve block **1144** carried on the gun slide **12**. A passage and conduit **1142***c* extends from one end of valve chamber **1142***a* to a portion of arm **1104** and axially of the pivot shaft **1110** thereof and then to valve chamber **1144***a*. A valve **1145** is disposed in valve chamber **1144***a* and has rods at each end which in the right-hand tray extend respectively to solenoids SO1 and SO2 so that said valve is operated by said solenoids. In the left-hand tray said rods operate solenoids SP1 and SP2. Said valve rods are arranged in the right-hand tray to respectively actuate switches IO101 and IO102 disposed at the remote sides of solenoids SO1 and SO2 respectively. In the left-hand tray said rods actuate switches IP101 and IP102. A conduit and passage **1144***b* supplies liquid under accumulator pressure, hereinafter referred to as PA, to valve chamber **1144***a* and passages and conduits **1144***c* supply liquid under lesser pressure of about 50 pounds, hereinafter referred to as PC, to the respective ends of valve chamber **1144***a*.

The shutter **1100***a* on each transfer tray has secured thereto a lug and arm **1100***c* (see FIG. 82) to which is pivotally connected a link **1148** which is in turn pivotally connected at its other end to a lever **1149** swingable about a shaft **1150** mounted in a lug on tray **1100**, said lever carrying an adjustable stud **1151** adapted to engage the actuating plunger of a switch. In the right-hand transfer tray, stud **1151** engages a switch IO9 and in the left-hand transfer tray, stud **1151** engages a switch IP9. One of the round-clamping members **1136** has an arm **1136***a* mounted on the shaft to which member **1136** is received in which is carried an adjustable stud **1153** (see FIG. 79), which in the movement of member **1136** is adapted to engage and actuate spaced switches. In the right-hand transfer tray when members **1136** are in non-clamping position, stud **1153** actuates switch IO7A, and when member **1136** is in round-clamping position (see FIG. 79), stud **1153** actuates switch IO4B. Said switches IO7A and IO4B thus respectively indicate that the round-clamping member **1136** is in clamping or unclamping position.

In the left-hand transfer tray, when member **1136** is in non-clamping position (see FIG. 83), stud **1153** actuates switch IP7 and when member **1136** is in clamping position, stud **1153** actuates switch IP4. When the shutter **1100***b* is in closed position it permits actuation of a switch IP3A, which indicates that said section is now closed. A link **1156** is pivotally connected to section **1100***b* beyond or inwardly of the axes of shafts **1108** on which said section is pivoted so that when said section moves to closed position, link **1156** will engage and operate switch IP3A, and when shutter **1100***b* moves to open position, member **1156** also permits spring actuation of switch IP3A in the left-hand tray and switch 1O3A in the right-hand tray.

A switch IP2A is adapted to be actuated by a bell crank lever **1157** (see FIG. 86), which is pivoted on a shaft **1155** carried in a lug on casing **1100**. Lever **1157** carries a roller **1158** adapted to be disposed in the transfer tray. Roller **1158** will be pushed outward by the round of ammunition when it enters the transfer tray and this will swing lever **1157** to permit actuation of switch IP2A. Switch IP2A thus indicates that there is a round of ammunition in the tray. Lever **1157** is spring-pressed to the position shown in FIG. 86. On the right-hand transfer tray, lever **1157** cooperates with a switch IO2A. Shutter **1100***b* on the right-hand tray actuates a switch IO3A.

Each transfer tray has at its rear end a door **1143** hinged at one end on a pintle **1146**. The door is locked in position by a spring-pressed plunger having a handle **1147**.

The arm **1104** of each transfer tray has connected thereto a link **1160** which is pivotally connected to a rod **1161***a* connected to a piston **1161** which is movable in a chamber **1163***a* in a block **1163** carried on the gun slide **12**. Link **1160** at its other end is connected to a shaft **1159** carried in arm **1104**. Arm **1104** has a substantially cylindrical reinforcing portion **1104***b* in one end portion of which shaft **1159** is disposed. A passage **1163***b* extends from one end of chamber **1163***a*, the same having a check valve **1164** therein, said passage extending to a valve chamber **1163***c* formed in block **1163**. A short passage **1163***b***1** extends from chamber **1163***a* to passage **1163***b* a short distance from the top of chamber **1163***a*. A passage **1163***d* extends from the other end of chamber **1163***a*, the same having therein a check valve **1165** and extending to a valve chamber **1163***e* also formed in block **1163**. Valves **1167** and **1168** are respectively disposed in valve chambers **1163***c* and **1163***e*. A short passage **1163***d***1** extends from chamber **1163***a* to passage **1163***d* a short distance from the bottom of chamber **1163***a*. Piston **1161** is provided with a plurality of circumferentially spaced grooves **1161***b* extending some distance from its top and bottom respectively. Grooves **1161***b* are tapered in depth toward their closed ends. Annular grooves **1163***j* about chamber **1163***a* communicate with grooves **1161***b*. Valve **1167** is connected to a latch **1170** shown as in the form of a bell crank lever, the end of one arm of which engages a shoulder **1171***a* on a vertically movable latch bar **1171** which is connected by the pin **1172** to the upper end of valve rod **1161***a*. The other arm of latch **1170** has connected thereto a tensile coiled spring **1173** which at its other end is connected to one arm of another latch **1175** in the form of a bell crank lever and to which valve **1168** is pivotally connected. The end of one arm of latch **1175** is adapted to engage a shoulder **1171***b* on latch bar **1171**. Latches **1170** and **1175** are pivoted to lugs on valve block **1163**. Latch **1170** when in unlatching position is adapted to engage and actuate in the left-hand tray, switches IP8A and IP1A. Latch bar **1171** in its lower position operates a switch IP5A. Latch **1175** when in unlatching position is adapted to operate in the left-hand tray, a switch IP6A,B,C,D.

Referring particularly to the left-hand tray, FIG. 86, a passage and conduit **1163***f* extends from the end of valve chamber **1163***c* to a valve chamber **1178***a* in a valve block **1178** supported on the gun slide **12**. A valve **1180** (see FIG. 90) is movable in valve chamber **1178***a* and has a valve rod connected to an arm **1181** secured to a shaft **1183**, which shaft extends to and is secured to a lever **1184**, substantially midway between the ends thereof. Lever **1184** fulcrums and swings about the axis of shaft **1183**. Lever **1184** is connected adjacent one end to a solenoid SP3 and is connected adjacent its other end to a solenoid SO3. Lever **1184** has a projection adjacent solenoid SP3 which is adapted to engage the actuating plunger of a switch IO103AB and also has a projection at its other end arranged to engage the actuating plunger of a switch IP103AB.

Another passage and conduit **1163***g* extends from the end of valve chamber **1163***e* (see FIGS. 86 and 90) to a valve chamber **1178***b* formed in block **1178**. A valve **1186**

(see FIG. 90) is movable in chamber 1178*b* and comprises a rod pivotally connected to an arm 1187 in turn connected to a shaft 1188. Shaft 1188 is connected to a lever 1189 midway between the ends thereof. Lever 1189 fulcrums about the axis of shaft 1188 and is connected adjacent one end to a solenoid SO4. Lever 1189 is connected adjacent its other end to a solenoid SP4. Lever 1189 has a projection at one end adjacent solenoid SO4 adapted to engage and actuate a switch IO104AB and at its other end has a projection adapted to engage and actuate a switch IP104A. Valve chambers 1178*a* and 1178*b* communicate with larger chambers 1178*f* and 1178*g*. A passage and conduit 1178*c* connects valve chamber 1178*a* and 1178*b*. A passage 1163*h* (see FIG. 86) extends from the side of valve chamber 1163*e* to a valve chamber 1190*a* formed in a valve block 1190 supported upon the gun slide 12. (See FIG. 90.) A passage and conduit 1163*i* extends from one side of valve chamber 1163*c* to valve chamber 1190*a*.

Referring particularly to the right-hand tray, FIGURE 87, a valve block 1163R similar to valve block 1163 is provided for the right-hand transfer tray, block 1163 being for the left-hand transfer tray. The parts 1161, 1161*a*, 1161*b*, 1163*b*1, 1163*d*1, 1163*a*, 1163*b*, 1163*c*, 1163*d*, 1163*e*, 1164, 1165, 1167, 1168, 1170, 1171, 1171*a*, 1172, associated with valve block 1163R are identical with those similarly numbered in valve block 1163. Piston 1161R is identical with piston 1161. A spring 1173 connects latches 1170R and 1175R. When latch 1170R of the right-hand tray is in unlatched position it is arranged to engage and actuate switches IO8A and IO1A. When latch 1175R of the right-hand tray is in unlatched position it is adapted to engage and actuate a switch IO6A,B,C,D. Latch bar 1171 of the right-hand tray in its lower position actuates a switch IO5A. A passage and conduit 1163*f* extends from one end of valve chamber 1163*c* in block 1163R to valve chamber 1178*e*. Another passage and conduit 1163R*g* extends from the end of valve chamber 1163*e* in block 1163R to passage 1163*g* adjacent valve chamber 1178*b*. An extension passage 1163R*g*1 extends from passage 1163R*g* to one end of valve chamber 1194*c* in a valve block 1194 to be later described. (See FIGURE 89.) A passage and conduit 1163R*h* extends from the side of valve chamber 1163*e* in block 1163R to the valve chamber 1190*a*. A passage and conduit 1163R*i* extends from one side of valve chamber 1163*c* in block 1163R to passage 1163*i* and thence to valve chamber 1190*a* in valve block 1190. A branch 1163*j* extends from conduit 1163*i* to PS or tank. A valve 1192 is disposed in valve chamber 1190*a* in block 1190 and is moved in one direction by a spring 1190*c*. A passage 1190*f* extends from the top to the bottom of valve chamber 1190*a* with which passages 1163*i* and 1208*c* communicate. Passage 1190*f* has a restriction 1190*g* therein.

The empty case tray

An empty case tray 1400 is provided carried on spaced arms or frames 1400*a* and 1400*aa* which are swingable on coaxially aligned shafts 1401 and 1402 respectively secured in spaced bearings 1403 secured to the gun slide 12. (See FIGURES 1, 89 and 92.) Said empty case tray comprises a substantially cylindrical casing having an opening 1400*b* at one side thereof. Tray 1400 is open at its forward end and at its rear end is provided with a door 1405 extending centrally thereacross and pivoted to swing about a shaft 1406 secured in lugs on said tray at either side of said door. (See FIGURES 93 and 94.) Door 1405 is locked in closed position by a plunger 1404 movable in a lug 1400*c* on said door and movable into a socket in another lug 1400*d* on said case. Plunger 1404 carries a pin 1407 extending into the end of a release lever 1408 pivoted on a stud 1409 in door 1405 and having a handle portion which is connected by a tensile coiled spring 1410 to a lug 1405*b* on door 1405. The spring 1410 holds handle lever 1408 in position with plunger 1404 in locking position. Door 1405 is provided with a knob handle 1411. Plunger 1404 can be released by swinging lever 1408 against the tension of spring 1410 and the door can then be swung about its hinge pintle 1406 by taking hold of handle 1411. Door 1405 is provided to give access to the parts carried thereon and also to remove an empty case from tray 1400.

A buffer is disposed at the rear end of empty case tray 1400 and is carried on door 1405 at the inner side thereof. Said buffer comprises a plunger 1414 projecting from a casing 1415 secured by a plurality of bolts 1416 to door 1405. Plunger 1414 has a collar forming a shoulder against which bears one end of a compression coiled spring 1417 disposed in a chamber in casing 1415, the other end of which is seated in a groove in the end of casing 1415. Plunger 1414 has a chamber 1414*a* therein of cylindrical form into which projects a spud 1418 supported in the end of casing 1415 and which is provided in its periphery with tapered grooves 1418*a*. A casing 1420 is secured to one side of casing 1415 and has a bore therein communicating with the bore in casing 1415 and open at its end opposite casing 1415. A bushing 1421 is disposed in the open end of casing 1420 having a reduced portion about which fits a compression coiled spring 1422 having one end engaging bushing 1421. A plunger 1424 fits in bushing 1421 and has a closed upper end and also has a flange extending over the top of spring 1422. Chamber 1414*a* and the chambers in casings 1415 and 1420 contain a fluid such as oil. Plunger 1424 can thus be forced downwardly against the pressure of spring 1422 by the fluid in casings 1415 and 1420.

When the empty case 1425 is discharged from the gun, it enters tray 1400 and strikes plunger 1414. Plunger 1414 is moved rearwardly against the pressure of spring 1417 and is also retarded by the fluid in the bore thereof passing out through the slots 1418*a*. The fluid discharge in the casing 1415 will press upon plunger 1424 which will also be moved downward against the pressure of spring 1422. The empty case 1425 is thus retarded and brought to rest in the tray 1400.

At one side of tray 1400 a bracket 1430 is secured in which is disposed a shaft 1431 on which is oscillatably mounted a pawl 1432 projecting into the tray 1400 at an acute angle to the axis thereof. (See FIGURES 95 and 96.) Panel 1432 has an end, the sides of which are at an acute angle so that it is somewhat pointed. A pawl-like member 1434 is carried on a shaft 1435 in a lug 1436 on casing 1400. A torsion coiled spring (not shown) is disposed about shaft 1435 and tends to hold member 1434 in the position shown in FIGURE 95. Member 1434, as shown in FIGURE 95, has a projection at its end disposed without tray 1400 which is adapted to engage the actuating plunger of a switch IS1AB. Shaft 1431 extends through a bearing bracket 1438 on tray 1400 and has secured at one end a handle lever 1440. (See FIGURE 93.) A member 1441 is secured to shaft 1431 at one side of bearing 1438 having a portion extending over a compression coiled spring 1442, the other end of which engages a projection on bracket 1438. (See FIGURES 92, 93 and 96.) Spring 1442 thus acts to hold pawl 1432 in its inward position as shown in FIGURE 95.

When the empty case PC is projected into tray 1400, the projecting rim or flange PC*a* at the end thereof will engage pawl 1432 and press the same outwardly and when said rim or flange passes the end of said pawl the pawl will drop behind the same due to the pressure of spring 1442 so that the empty case cannot again move forwardly or toward the gun. The empty case moves past member 1434 and rebounds from plunger 1414 and

the inner end of member 1434 moves inwardly and engages the edge of the rim PC*a* and actuates switch IS1AB. Pawl 1432 holds the case against the side of casing 1400. Switch IS1AB indicates that an empty powder case is now in the tray. Pawl 1432 can be swung to move out of tray 1400 by swinging handle lever 1440. The arm 1440 projects at one side of the empty case tray and as the tray swings down to its receiving position the same engages an adjustable bolt 1444 carried in a bracket 1444*a* secured to valve block 1194 (see FIG. 88), and portion 1440 is thus swung and swings shaft 1431 which in turn swings pawl 1432 and member 1434 upwardly to the top of the empty case tray and above the empty powder case. The empty powder case is thus now free to be ejected.

A valve block 1194 is provided which will be supported on the gun slide 12, the same having therein a valve chamber 1194*a* in which is movable a piston or valve 1195. (See FIG. 89.) Valve 1195 has a rod 1195*a* extending upwardly therefrom which is pivotally connected at its upper end to a link 1193 which is pivotally connected at its upper end by a pivot 1197*a* to the arm 1400*a* which carries the empty case tray. Valve 1195 also has a rod extending through the lower side of valve block 1194. A latch bar 1196 is connected at its upper end to the upper end of rod 1195*a* by pivot 1197 and extends downwardly in block 1194, the same having latching shoulders 1196*a* and 1196*b* thereon. Shoulder 1196*b* is adapted to be engaged by a latch member 1198 in the form of a bell crank lever pivoted to a lug on valve block 1194. The other arm of latch 1198 has connected thereto a tensile coiled spring 1199, the other end of which is connected to one arm of a latch member 1200, shown as a bell crank lever, pivoted to a lug on block 1194, the lower end of which is adapted to engage latch shoulder 1196*a*. Latch 1198 has its latching arm pivotally connected to one end of a valve 1202 movable in a valve chamber 1194*b* in block 1194. Latch member 1200 has its latching arm pivotally connected to one end of a valve 1203 movable in a valve chamber 1194*c* in block 1194. A passage 1194*d* extends from one side of valve chamber 1194*b* to the upper end of valve chamber 1194*a*, said passage having a spring pressed check valve 1204 therein. A short passage 1194*dl* extends from valve chamber 1194*a* to passage 1194*d* a short distance from the top of said chamber. Another passage 1194*e* extends from one side of valve chamber 1194*c* to spaced points at the lower portion of valve chamber 1194*a*, said passage also having a spring-pressed check valve 1205 therein. A short passage 1194*el* extends from valve chamber 1194*a* to passage 1194*e* a short distance from the bottom of chamber 1194*a*. Plunger 1195 is provided with a plurality of circumferentially spaced grooves 1195*b* which extend some distance from its ends. Grooves 1195*b* taper in depth toward their closed ends. Auxiliary grooves 1194*j* about chamber 1194*a* communicate with grooves 1194*b*. A passage and conduit 1194*f* extends from one end of valve chamber 1194*b* to valve chamber 1178*b*. A passage and conduit 1194*g* extends from one side of valve chamber 1194*c* to passage 1163R*i*. A passage 1194*h* extends from one side of valve chamber 1194*b* to passage 1163R*h*.

A block 1208 is supported on the gun slide 12 and has therein a valve chamber 1208*a*. (See FIG. 86.) A plunger 1209 is movable in chamber 1208*a* and is connected by a link 1210 to an arm 1104*d* on member 1104 adjacent shaft 1110. A passage 1208*b* extends from the closed end of valve chamber 1208*a* to a conduit 1208*c* which extends to the closed end of a chamber 1212*a* in a block 1212 (see FIG. 87) supported on the side of the gun slide opposite valve block 1208. A plunger 1214 is movable in valve chamber 1212*a* and is connected by a link 1215 to an arm 1104*e* on member 1104 adjacent one of the shafts 1110 of the right-hand transfer tray. A block 1218 is supported on the gun slide and has therein a chamber 1218*a* in which is movable a plunger 1219 connected by a link 1220 to an arm 1400*e* connected to arm 1400*a* adjacent shaft 1401. A conduit and passage 1218*b* connects the closed end of chamber 1218*a* to conduit 1208*c*.

As stated, the transfer trays are swung from an upper receiving position downwardly to a position in axial alignment with the gun barrel. As each transfer tray is swung to its upper position, the shutter 1100*a* and swinging section 1100*b* are swung to open position by springs 1105 and 1108. When the round of ammunition is transferred by the cradle into the transfer tray, member 1158 is engaged by the powder case and lever 1157 is swung to permit actuation of switch IP2A. A corresponding switch on the right-hand tray is numbered IO2A. These switches indicate that the transfer trays are loaded. Switch IO3A on the left-hand tray corresponds to switch IP3A on the right-hand tray.

Operation of transfer trays and empty case tray

When switches 1S1AB indicating that an empty case is in the empty case tray, 1W1ABC indicating that the breech block is lowered, 1R2A indicating that the rammer is retracted, IL101A indicating that the fuse setter is retracted, IJ5B indicating that the cradle ejectors 1005 are retracted, 1S2AB indicating that the member 1454 of the empty case ejector is retracted, and switch IW3AB indicating that the gun is within 3.842 inches of battery, are operated, an electrical circuit is closed and solenoid SO2 is actuated. This moves valve 1145 to its upper position. PA now passes from passage 1144*b*, around valve 1145 and through passage and conduit 1142*b* to the closed end of valve chamber 1142*a*. This moves piston 1141 to the position shown in FIGS. 77 and 81, and lever 1134, arm 1131 and link 1128 are swung so that arm 1126 swings shutter 1100*a* to closed position. Lever 1134 also swings link 1133 so that the round-clamping members 1136 are moved to the position shown in FIG. 77 and the round of ammunition is clamped in the transfer tray. The parts just described are those entitled in the showing of the right-hand transfer tray in FIG. 77. The mechanism for the left-hand transfer tray, shown in FIG. 81, is identical except that the solenoids numbered SP1 and SP2 correspond respectively to solenoids SO1 and SO2. Switches IO101 and IO102 on the right-hand tray correspond to switches IP101 and IP102 respectively in the left-hand tray. PC which is less than PA is on the lower side of piston 1141 or on its rod side and this is overcome by the PA. When the arm 1126 is moved to close shutter 1100*a*, shafts 1101 are oscillated and this moves lever 1112 (see FIG. 78), and the chain 1111, so that the swinging section 1100*b* is pulled to closed position by said chain. By reference to FIG. 78, it will be seen that the end link of the chain is connected to arm 1100*c* below the axes of shafts 1107 so that when chain 1120 is pulled downwardly it swings section 1100*b* to closed position. It will be noted that pin 1113 would now be in the bottom of slot 1117*a*. Both shutter 1100*a* and section 1100*b* are now closed and the round is clamped by clamping members 1136. The transfer tray is now ready to be swung to its lower position.

In FIGS. 86, 87 and 88, the transfer trays and the empty case tray are shown in their upper positions. When one of the transfer trays is to be swung downwardly, for instance the left-hand transfer tray, and switch I04B is closed indicating that the round is clamped in the tray by members 1136, solenoids SO4 and SP3 will be energized. Valve 1186 will then be in the position opposite that shown in FIG. 90 and valve 1180 will be in the position shown in FIG. 90. Solenoids SO3, SO4, SP3 and SP4 are pull solenoids. This selects the left-hand tray to be lowered. Solenoid SO3 moves valve 1180 to its position shown in FIG. 90 and solenoid SP3 moves valve

1186 to its left position, as seen in FIG. 90. PA can now pass from conduit and passage 1178*d*, around valve 1186, around valve 1130, through conduit and passage 1163*f* to the end of valve chamber 1163*c* of the left-hand tray. (See FIG. 86.) Valve 1167 is moved to the right and latch 1170 is moved to disengage it from shoulder 1171*a* on the latching bar 1171. As latch 1170 is thus moved, spring 1173 swings latch 1175 so that its latching end is moved against latch bar 1171. When valve 1167 is moved to the right, it opens passage 1163*b* and PA is placed on the top of piston 1161 which is thus moved downwardly moving its rod 1161*a* downwardly and swinging link 1160 to swing arm 1104 about shaft 1110 and swinging the transfer tray to its lower position. When the lower end of piston 1161 passes passage 1163*dl*, fluid below said end is trapped as check valve 1165 will close. The fluid is then forced through annular groove 1163*j* into grooves 1161*b*. This acts to decelerate piston 1161 and the transfer tray. When piston 1161 moves downwardly, latch bar 1171 is moved downwardly therewith and when notch 1171b passes latch 1175, which as stated is now held against the latch bar, the latching end of latch 1175 will move into notch 1171*b* and bar 1171 will be latched in its lower position. When latch bar 1171 moves downwardly it operates switch IP5A. Said switch will indicate that the left-hand tray is now in discharge or ram position. When latch 1170 was moved by valve 1167, switches IP8A and IP1A were actuated. When latch 1175 is operated by spring 1173, switch IP6A,B,C,D will be actuated. The movement of latch 1175 by spring 1173 also moves valve 1168 to the left.

PA also passes from passage and conduit 1178*d* (FIG. 90) around valve 1186 to passage 1194*f*. This pressure moves valve 1202 to the right, as shown in FIG. 89, and latch 1198 is moved out of notch 1196b of latch bar 1196 so that said bar is unlatched. Spring 1199 swings latch 1200 to bring its latching end against bar 1196 and also moves valve 1203 to the left. The movement of latch 1198 operates switches IS8A and IS1A. Movement of latch 1200 away from switch IS5A,B,C, will allow the same to be actuated. When valve 1202 is moved to the right, PA can now pass through passage 1194*d* to the upper end of piston 1195. Valve 1195 will now move downwardly and will pull upon link 1196 which will swing arm 1400*a* downwardly, thus swinging the empty case tray 1400 from its position in axial alignment with the gun barrel to its lower discharge position. When the lower end of piston 1195 passes passage 1194*cl*, the fluid below said end will be trapped as valve 1205 will be closed. The fluid must then pass through annular groove 1194*g* into grooves 1195*b*. This will decelerate piston 1195 and thus the empty case tray. The empty case tray is thus swung down to its discharge position each time one of the transfer trays swings down to discharge position.

The operation of the other or right-hand transfer tray is identical with that of the left-hand tray. To lower the right transfer tray, solenoids SO4 and SO3 are energized and valves 1180 and 1186 are moved to their other position from those shown in FIG. 90. PA now passes around said valves and through conduit 1163R*f* to the right-hand end of valve 1167R operating latches 1170R and 1175R as above described. PA passes through passage 1163*b* to the upper end of valve 1101R and the right-hand tray is swung downwardly. (FIGS. 87 and 90.) PA also passes around valve 1180 to passage 1194*f* to valve chamber 1194*b*, thus moving valve 1202 to the right, uncovering passage 1194*d* and putting PA on top of piston 1195. Piston 1195 is moved down and the empty case tray 1400 is swung to its discharge position. It is believed a more specific description of this operation will be unnecessary.

Before the transfer tray is swung downward, the shutter 1100*a* and the section 1100*b* have been moved to closed position, as above described. When the transfer tray approaches its lower position and is within about 15 degrees therefrom, the latch bar 1171 will operate switch IO5A, as stated, and this will operate solenoid SO1 to change the position of valve 1145. PA will now be directed to the other side of piston 1141 and it will move from the position shown in FIG. 77 to its upper position. This will swing lever 1134, and the round-clamping members 1136 will be moved outwardly thus releasing the round. About the same time that switch IO5A is operated, the cam roller 1123 has moved around on cam 1124 swinging bell crank lever 1120 and moving link 1117 so that pin 1118 is now in the end of the slot 1117*a* and lever 1112 is held in position to still pull upon chain 1120 and hold section 1100*b* closed and arm 1112 is held in position closing shutter 1100*a*. The cam 1117 thus begins operation to hold the shutter and swinging section closed when valve 1145 is moved. The transfer tray thus comes to its lower position with the round-clamping members 1136 released and the shutters thereof in closed condition. The transfer tray thus comes to its lower position and the round can then be rammed into the gun barrel by the rammer.

The empty case tray must be moved downward when the transfer tray is moved downward else the former would interfere with the transfer tray. When the left-hand transfer tray is moved downward, arm 1104*d* is swung with arm 1104 and this moves plunger 1209 downwardly in plunger chamber 1208*a*. This forces liquid out through passages and conduits 1208*b* and 1208*c*. If the empty case tray is being moved downward, valve or plunger 1219 will be moved downward by arm 1400*e* and link 1220. The liquid forced out of valve chamber 1208*a* can thus move through conduits 1208*c* and 1218*b* into valve chamber 1218*a*. (See FIG. 89.) The liquid will thus be merely transferred from one of said valve chambers to the other. Should the empty case tray for any reason not be moved, as when it might become stuck the liquid cannot pass into valve chamber 1218*a*. It would then be forced through conduit 1208*c* to the lower side of plunger 1192 (see FIG. 90) in valve chamber 1190*a*. Valve 1192 will be moved upwardly and its lower land will close the port 1190*b* leading to passages 1163*h* and 1194*h*. The fluid in conduit 1208*c* will be forced into valve chamber 1190*a*. However since the outlet port 1190*b* is now closed, there is no outlet from chamber 1190*a* and movement of plunger 1161 and thus movement of the transfer tray will be stopped. The fluid could pass through restriction 1190*g* and this would slow up the motion of the transfer tray so that no damage would be done if it contacted the empty case tray. The movement of the transfer tray is thus arrested and no damage will result. It is thus necessary for the empty case tray to move down properly or the movement of the transfer trays will be stopped. It will be noted that the liquid moved in the respective valve chambers 1163*e* can move through the conduits 1163*g* and 1163R*g* which are connected so the fluid will be moved from one of the valve chambers 1163*e* to the other. Passage 1163*j* leads to tank or low pressure PS. When valves 1167 and 1167R are moved to the right, the fluid can pass through passages 1163*i* and 1163R*i* to passage 1163*j* and to PS or tank.

To return the transfer tray to upper position, switch IS3A will be operated indicating that the empty case ejector member 1454 is five inches or less from forward position and switch IR3C must be closed indicating that the rammer is ten inches away from forward position. An electrical circuit is closed by said switches and solenoid SP4 will then be energized and valve 1186 will be moved to the position shown in FIG. 90. PA can now pass from passage and conduit 1178*d* to and around valve 1186 to conduit 1163*g*. This will move valve 1168 to the right, as shown in FIG. 86, and release latch 1175. Latch 1170 will be positioned by spring 1173 ready to engage shoulder 1171*a*. PA will pass through passage 1163*d* to the lower end of chamber 1163*a* and piston 1161 will be moved to its upper position thus

swinging tray 1100 to its upper position shown in FIG. 86. Piston 1161 and the transfer tray will be decelerated as fluid will be trapped above said piston when its upper end passes passage 1163*bl* and this trapped fluid will be forced through annular groove 1163*j* and into grooves 1161*b*. Valve 1164 will be forced to closed position. Latch 1170 will engage bar 1171 and the tray will be latched in its upper position.

PA will also pass through conduits 1163R*g* and 1163*g* to valve chamber 1194*c* and valve 1203 will be moved to the right, as shown in FIG. 89. Latch 1200 will be moved to unlatched position and latch 1198 will be moved against rod 1196 into position ready to engage shoulder 1196*b*. PA will pass through passage 1194*e* to the lower end of piston 1195 and said piston will move its rod 1195*a* upwardly and swing the empty case tray 1400 to its upper position. When the upper end of piston 1195 passes upper passage 1194*dl*, fluid above said end will be trapped and forced through annular groove 1194*j* into grooves 1195*b*. Valve 104 will be forced to closed position. Piston 1195 and thus the empty case tray will be decelerated.

Said tray will be held in its upper position by latch 1198. The left-hand transfer tray and the empty case tray have now been moved to their upward positions. The operation would be similar for the right-hand tray. Solenoid SP4 will be energized and valve 1186 (FIG. 90) will be moved to the position shown in FIG. 90. PA can pass through passages 1163R*g* and 1163R*gl* and this as described will raise the right-hand tray and the empty case tray. Valves 1180 and 1186 can be set only to lower one transfer tray at one time. Passages 1163*f* and 1163R*f* which carry fluid for lowering the transfer trays respectively cannot receive PA at the same time.

FUSE SETTER AND FUSE POT MECHANISM

When the round has been placed in the transfer tray and held clamped therein the fuse is set on the projectile. (See FIG. 97.) The projectile is engaging the powder case at one end and the powder case is engaging member 1102 at one end of the transfer tray. A member 1530 is provided which is slidable on a portion of the slide 12 at the front of the transfer tray. Member 1530 carries therein the fuse pot 1531 and also has contained therein a fuse setting mechanism. The member 1530 and parts carried thereby forms part of the present invention. Member 1530 has a rod 1532 connected thereto and projecting therefrom pivotally connected at one end to one end of link 1534, the other end of said link being connected to a plunger valve 1535 which extends into a valve chamber 1536*a* in a cylinder 1536. Plunger 1535 has an enlarged end portion 1535*a* which is tapered at both ends. Plunger 1535 also has a bore 1535*aa* therein at its inner end to receive a cylindrical portion 1536*b* connected to and projecting from the inner end of cylinder 1536. Portion 1536*b* is provided with a bore, and a passage and conduit 1538 extends therefrom through the end of cylinder 1536 and to a chamber 1539*a* in a valve block 1539 carried on the gun slide 12. A passage and conduit 1540 extends from chamber 1539*a* to one end of chamber 1536*a* Another passage and conduit 1542 extends from one end of chamber 1539*a* to adjacent the closed end of chamber 1536*a*. Another passage and conduit 1543 extends from an intermediate point in chamber 1439*a* to an intermediate point in chamber 1536*a*, the same having a check valve 1544 therein arranged to be closed by liquid under pressure moving from chamber 1539*a*. At the side of check valve 1544 remote from cylinder 1536 a passage 1545 extends from passage 1543 to a valve chamber 1536*c* formed in a portion of cylinder 1536. A spring-pressed valve 1546 of cylindrical shell shape is disposed in chamber 1536*c* and held by a spring 1533 against one end wall of chamber 1536*c*. When valve 1546 is at one end of chamber 1536*c*, as shown in FIG. 97, the end edge of said valve is flush with one side of passage 1545. A passage 1536*d* extends from one end of chamber 1536*c* to chamber 1536*a*. A passage 1539*b* extends from one end of chamber 1539*a* to the outer side of block 1539, the same being shown as in alignment with passage 1542. Passage 1539*b* is connected with a supply of liquid under super-charge pressure. Another passage 1539*c* extends from adjacent the other end of chamber 1539*a* to the outer side of block 1539 and to tank. A passage 1539*d* connects passages 1539*b* and 1539*c* within block 1539. A passage 1539*e* extends from an intermediate point in chamber 1539*a* to the outer side of block 1539 and will be connected to a supply of liquid under accumulator pressure or PA. A valve 1550 is movable in chamber 1539*a*, the same comprising spaced lands and having a valve rod 1550*a* extending to without block 1539 and connected at its end to a lever 1551. Lever 1551 is pivoted substantially midway of its length by pin 1552 to a lug 1553 projecting from a portion of the gun slide 12. Lever 1551 is pivotally connected at the end adjacent rod 1550*a* to the plunger or core of a solenoid SL2. At its other end, lever 1551 is connected to the plunger or core SL1*a* of a solenoid SL1. Core SL1*a* is provided with a plurality of spaced recesses SL1*b* in either of which a spring-pressed detent 1558 is adapted to be disposed. A switch IL102A is disposed at the side of lug 1553 adjacent solenoid SL1 adapted to be actuated by lever 1551 when solenoid SL1. Core SL1*a* is provided with a plurality of spaced at the side of lug 1553 adjacent solenoid SL2 and is adapted to be actuated by lever 1551 when solenoid SL2 is energized.

Operation of fuse pot

In operation, when the round of ammunition has been placed in the transfer tray and has been gripped therein by the members 1136, and the end of the powder case is in engagement with member 1102, the switch IO4B has been actuated to close an electrical circuit and energize solenoid SL1. This will swing lever 1531 to move valve 1550 to the left, as seen in FIG. 97. PA now enters passage 1539*e* and passes around valve 1550 between the lands thereof and into passage and conduit 1538. This PA engages the end of a bore 1535*aa* in valve 1535 and moves the same to the left, as shown in FIG. 97. The liquid in chamber 1536*a* passes out through passage and conduit 1543, opening check valve 1544. As the pressure increases in chamber 1536*a* due to the movement of valve 1535, some of the liquid will act on valve 1546 which will gradually cut off passage 1545. This, together with the tapered end of valve head 1535*a* trapping liquid, acts to decelerate the movement of valve 1535. The member 1530 is now moved toward the transfer tray and the fuse pot 1531 is moved over the ogive of the projectile. The fuse-setting operation will now take place. A lug in the fuse pot will engage in a recess in the projectile and be rotated to set the fuse. The fuse-setting mechanism per se forms no part of the invention. After the fuse has been so set, and switch IR1C, indicting that the rammer is twelve inches or more from fire position, solenoid SL2 is energized and lever 1551 and valve 1550 are moved to the position shown in FIG. 97. PA now enters passage 1539*e* passing around the valve 1550, between the lands thereof and into passage and conduit 1540, and then into chamber 1536*a*. This pressure now engages the annular portion of valve 1535 and the same is moved to the right, as shown in FIG. 97. The liquid at the right of the valve is forced out through passage 1542 and into the supercharge passage 1539*b*. The right-hand end of valve head 1535*a*, is tapered and this results in a deceleration of said valve when it approaches the end of chamber 1536*a*. Switches IL101A and IL102A are actuated in the different positions of lever 1551 respectively and indicate the status and position of the fuse pot. The fuse is thus set while the round of ammunition is in the transfer

tray and before the transfer tray is lowered to its discharging position in axial alignment with the bore of the gun.

THE RAMMER

A rammer is employed to ram the round of ammunition from a transfer tray into the breech of the gun. This rammer mechanism includes a cylinder **1700***a* in which is movable a plunger **1701**, which plunger engages the rear end of the powder case and pushes said case and projectile in front of the powder case into the gun. Plunger **1701** is cushioned with a fluid, said fluid being somewhat compressed under pressure of plunger **1701**. Cylinder **1700***a* is carried by and forms part of a spade **1700**. Spade **1700** has a slide portion **1700***b* which is rectangular in cross section and movable vertically in casing **1702***a*. The casing **1702***a* depends from a slide **1702** which has rectangular portions at either side movable in guide members **1705** secured to a supporting member or beam **1707**. Slide **1702** with the spade and other parts carried by said slide constitute the rammer. (See FIG. 102).

Portion **1700***b* has a vertical bore therein, in the lower end of which is disposed a collar **1700***bl* having an upwardly extending reduced central portion and a flange at the lower end. In said bore is a compression coiled spring **1704**, the bottom of which engages said flange on collar **1700***bl*. The upper end of spring **1704** engages a collar **1704***a* threaded into the enlarged upper end of casing **1702***a*. Spring **1704** thus acts to push the spade **1700** and the part **1701** carried thereby downwardly. When the rammer is moved toward the breech for ramming the round, the plunger **1701** is axially aligned with the round. When the breech block **1560** is moved to its operative position closing the breech, the spade **1700** is moved upwardly by the breech block to the position shown in FIG. 107, and spring **1704** is compressed. A rod **1715** is disposed in the bore in portion **1700***b* and extends through collar **1700***bl* and into a reduced portion of said bore, the same having a collar **1715***a* thereon and a nut threaded onto its lower end engaging said collar. (See FIG. 102). A cylindrical sleeve **1715***c* of small diameter surrounds rod **1715** and at its lower end engages collar **1715***a* and at its upper end engages a collar **1715***b* secured to rod **1715**. Rod **1715** extends through collar **1704***a* and has a head at its upper end in which is formed a semicylindrical groove **1715***d* extending horizontally in the rear side of said head. A small compression coiled spring **1715***e* surrounds sleeve **1715***c*, the same engaging collar **1700***bl* at its lower end and engaging collar **1715***b* at its upper end.

The spade has a recess **1700***c* in its forward side, and a pawl **1708** is mounted on the slide **1702** and adapted to enter said recess and latch the spade in its upper position. The spade occupies the said upper latched position while the rammer is moved away from the gun. The pawl **1708** is mounted on a shaft **1709** which is journaled in a lever **1710**. (See FIG. 100). An arm **1711** is carried at one end of shaft **1709** and as the spade nears its limit of retraction, arm **1711** engages a member **1712** so that arm **1711** and shaft **1709** are swung to move pawl **1708** out of recess **1700***c* and thus release the spade. Member **1712** is carried at the bottom of a lever **1713** swingable about a shaft **1713***a*. Lever **1713** carries a pin **1713***b* adapted to enter either one of two holes **1706***c* and **1706***d* in a bracket **1706** on guide **1705**. When pin **1713***b* is in hole **1706***d*, member **1712** is in position to engage arm **1711**. When pin **1713***b* is in hole **1706***c*, member **1712** is positioned so it will not be engaged by member **1711** and the spade will not be released.

The lever **1710** is pivotally connected at its rear end to a rod **1714** which is pivotally connected at its other end by pivot **1714***a* to a part of the slide **1702**. A compression coiled spring **1716** surrounds rod **1714**, the same acting to move the rear end of lever **1710** upwardly. The forward end of lever **1710** carries a roller **1718** which is arranged to engage a cam surface **1705***a* on guide **1705**. Roller **1718** engages the surface **1705***b* of the guide **1705** until the spade is almost at its limit of rearward movement and thus acts to hold pawl **1708** in engagement with the spade.

The beam **1707** at its rear end has a pin **1790** extending transversely therethrough, which is held in place by washers **1792** at the ends thereof. (See FIG. 104). A shaft **1794** extends between the rear ends of the sides of the gun slide **12**, which ends form what is termed the tail gate **12***c*. (See FIG. 1). Shaft **1794** is held in place by washers **1795**. A member **1796** is disposed between the ends of slide **12***c*, and shaft **1794** passes through the same. Member **1796** has a central depending tongue or plate **1796***a* which fits in a vertical slot **1707***c* in beam **1707** and through which pin **1790** passes. The beam **1707** is thus supported at its rear end by tongue **1796***a*, which forms in effect a one point support.

Beam **1707** at its front end has a pair of spaced depending lugs **1707***f* disposed between a pair of lugs **12***e* extending upwardly from the side **12**. A pin **1717** extends through lugs **12***e* and **1707***f*, the same being held in place by washers **1717***a*. Beam **1707** thus has a two point support at its front end. Beam **1707** at its forward portion is of general channel shape with its flanges directed upwardly. The center portion of beam **1707** is also of general channel form with its flanges directed downwardly at each side of rack **1756**. The rear end of beam **1707** is of general channel form with its flanges directed upwardly.

A valve block **1720** is provided which will be supported on beam **1707**. (See FIG. 107.) Valve block **1720** has therein a valve chamber **1720***a* in which is movable a valve **1722** pivotally connected through a link **1723** to one end of a lever **1724**. Lever **1724** is secured to a shaft **1726** to which another lever **1728** is secured, said latter lever extending some distance at either side of shaft **1726**. One end of lever **1728** is suitably connected to the core of a push solenoid SR1 and the other end is suitably connected to the core of a push solenoid SR2. Lever **1728** at one side of shaft **1726** is arranged to engage the actuating plunger of a switch IR102A when solenoid SR2 is energized. Lever **1728** is constructed at its other end to engage the operating plunger of a switch IR101A when solenoid SR1 is energized. Lever **1724** is provided in one end with spaced recesses adapted to be respectively engaged by a spring pressed detent **1732** to hold lever **1724** in one or the other of its two positions.

A passage and conduit **1720***b* extends to chamber **1720***a* and another passage and conduit **1720***c* extends to one end of chamber **1720***a*. Passage **1720***b* is connected to a supply of PA and passage **1720***c* is connected to a supply of liquid under lower or supercharge pressure, hereinafter referred to as PC. A passage **1720***d* extends from passage **1720***c* to the other end of chamber **1720***a*, the same being connected to an intermediate portion of chamber **1720***a* by a passage **1720***e*. A passage **1720***f* extends from an intermediate point in chamber **1720***a* to one end of a valve chamber **1720***g* in block **1720**. A valve **1734** is movable in chamber **1720***g* and has a rod at one end connected by a link **1736** to a lever **1737** pivoted at its other end on a shaft **1738** carried in a lug depending from slide **1702**. Lever **1737** is connected to a bar **1739** which is slidable relatively to slide **1702** and is provided with a cam surface **1740** adapted to engage a pin **1742** on a pawl **1743** pivoted at one end to a bracket **1744** mounted on the gun housing. The other end of pawl **1743** is arranged to engage a lug **1745** carried on slide **1702**. Pawl **1743** is urged to engaging position by a compression coiled spring **1746**. Pawl **1743** also carries a roller **1747**, adapted to engage a cam surface **1740***a* on the opposite side of guide **1705** to depress pawl **1743** and release the slide **1702**. The roller **1747** and cam surface **1740***a* are provided so that when the gun is firing and the gun and gun housing move back in recoil the pawl **1743** will be moved

by roller 1747 and cam surface 1740*a*. The rammer is thus released and will be retracted as described. Cam surface 1740 will release the rammer when the mount is being operated without firing.

A passage and conduit 1720*h* extends to an intermediate point of chamber 1720*g* and will have PA connected thereto. An annular groove 1720*i* extends about chamber 1720*g* in alignment with passage 1720*h* and a passage 1720*j* extends from said groove to near the rear end of a chamber 1720*k* in block 1720. A passage 1720*m* extends from passage 1720*j* to the end of chamber 1720*k* in which passage is disposed a spring pressed check valve 1748. A passage and conduit 1720*n* extends to an intermediate point in chamber 1720*g* and will have PC connected thereto. A passage 1720*o* extends from passage 1720*h* to adjacent the rear end of chamber 1720*g*. A passage 1720*p* extends from an intermediate point in chamber 1720*g* to the left-hand end of chamber 1720*k*, as shown in FIG. 107. A spring pressed check valve 1749 is disposed in passage 1720*p*. Another passage 1720*q* extends from passage 1720*p* to chamber 1720*k* a short distance from said left-hand end and has a spring pressed fluid metering valve 1750 therein. Valve 1750 comprises an open-end sleeve 1750*a* urged to one end of its chamber by a spring 1751. Sleeve 1750*a* has a small central aperture in the end engaged by spring 1751. A valve plunger 1752 is disposed and movable in chamber 1720*k*, the same having a reduced portion or rod extending to without block 1720 to which is secured a head portion 1752*a*. A shaft 1753 is journaled in portion 1752*a* and has secured thereto a gear 1754. Gear 1754 meshes with a stationary rack 1756 at the top of said gear which is carried on the beam 1707. At its bottom, gear 1754 meshes with a rack 1757 formed on the slide 1702 of the rammer. Portion 1752*a* extends rearwardly beyond shaft 1753 and has a reduced cylindrical portion 1752*b* adapted to engage the actuating plunger 1758 of a switch IR2A, carried on the beam 1707 when the rammer is in its rearmost position. Portion 1752*a* has a recess 1752*d* therein in which a spring pressed detent 1759 is adapted to enter when the rammer is at the limit of its rearward movement. (See FIG. 99.) The detent 1759 is provided to prevent movement of the rammer during any rolling or pitching of a ship on which the mount may be carried. It does not hold the rammer with sufficient force to interfere with the rammer reciprocating mechanism.

A switch IR4A is disposed near the rear end of the support or beam 1707, the same having an actuating lever arm 1762 pivoted on a shaft 1763. Arm 1762 is normally held spaced from the actuating plunger 1765 of said switch by a compression coiled spring 1766. Lever arm 1762 has a projecting pin 1767 adjacent its lower end adapted to be disposed in recess 1715*d* when the rammer is in its rearmost position.

Shafts 1770 and 1771 are journalled in the guides 1705 and have secured adjacent their lower ends respectively swinging arms 1772. (See FIG. 106.) Each of these arms carries a roller 1773 adapted to be engaged by a cam surface on the rammer slide 1702. The shafts 1770 and 1771 have secured to their upper ends, arms 1774 and 1775 respectively. These arms in the oscillation of shafts 1770 and 1771 engage rollers carried in the ends of arms 1776 and 1777 respectively. Said arms are secured to shafts 1778 and 1779 which actuate switches IR3A,B,C,D and IR1A,B,C respectively which are carried on the support or beam 1707.

When the spade is moved upwardly by the breech block, a part of the spade slide portion 1700*b* engages a portion 1782*a* of an arm 1782 pivoted about a pivot 1783 on beam 1705. Arm 1782 engages a rod 1787 slidable in beam 1705 and said rod is moved upwardly. Rod 1787 engages the actuating plunger of a switch IR5A, which switch indicates that the spade is in raised position. When pawl 1708 is released and the spade is moved down, portion 1700*b* is moved away from portion 1782*a* and spring 1784 swings arm 1782 counter-clockwise and downwardly. Spring 1786 then moves rod 1787 away from switch IR5A permitting operation of said switch. When roller 1718 passes cam surface 1705*a*, pawl 1708 is no longer held in latching position and is ready to be released.

In FIG. 107 the rammer or slide 1702 is shown at its forward position and the breech block 1560 has moved to its closed position and has moved the spade 1700 upwardly so that it is latched by pawl 1708. When the rammer is to be moved forwardly for ramming and switches IW1C indicating that the breech block is down, IO6A indicating that a transfer tray (assuming the right-hand tray) is in ramming position, IO7A indicating that the round clamping member of said tray is in unclamping position, a switch IW2AB indicating that the gun is within one-half inch of battery, IW8A indicating that the handle 1670 is in position for automatic or power operation of the breech block, IR2A and IR4A indicating that the rammer is retracted and the spade is down, and switches indicating that there is sufficient oil in the accumulator systems involved in the rammer operation, are actuated, an electrical circuit is closed and solenoid SR1 will be energized. This will move valve 1722 (FIG. 107) to the position shown. PA from passage and conduit 1720*b* is then blocked from valve chamber 1720*a*. PA from conduit and passage 1720*h* can pass through passage 1720*o* around the right-hand end of valve 1734, through passage 1720*j* to the right-hand side of chamber 1720*k*. Since PA is not now on the left-hand of valve plunger 1752 it will be moved to the left, as shown in FIG. 107. This will move portion 1752*a* and gear 1754 and said gear 1754 will be rotated by its engagement with stationary rack 1756 and will in turn move slide 1702 by its engagement therewith and the rammer will thus be moved forwardly. Plunger 1701 will engage the powder case in a transfer tray, which is now in discharge position, and said case and the projectile in front of the same will be rammed into the breach of the gun. The plunger 1701 will yield, as described, and the rammer will be buffed. Pawl 1743 will engage lug 1745 and the rammer will be latched in its forward position. Check valve 1749 will close in the ramming stroke. Some fluid will be trapped after piston 1752 passes passage 1720*g* and the tapered end of piston 1752 will act to decelerate said piston. Valve 1750 is a fluid metering valve. The PA pressure passes through the small central aperture in the valve sleeve 1750*a* and this causes a drop of pressure in said sleeve. Said sleeve may be moved to the right as shown in FIG. 107 and will then throttle the fluid to a reduced pressure. The rammer engages the gun housing, which latter acts as a stop for the forward movement of the rammer.

The breech block is now raised to operative position and the spade 1700 is moved upwardly by said block. The spade 1700 is latched in up position by latch 1708 engaging recess 1700*c*. Switch IR5A is operated as the spade and its portion 1700*b* moves upwardly swinging member 1782 upwardly and moving rod 1787 vertically. The parts are now in the position shown in FIG. 107.

When the rammer is to be retracted and a switch IR5A is actuated showing that spade 1700 is raised and in latched position, an electrical circuit is closed and solenoid SR2 is energized so that lever 1728 is oscillated, thus oscillating shaft 1726 and lever 1724 and moving valve 1722, as shown in FIG. 107, downwardly. With the parts as shown in FIG. 107, it will be seen that PA is on the right-hand side of valve 1752 which has moved this valve to the left and to the position shown in FIG. 107. There is always PA on the right-hand side of valve or piston 1752. When valve 1722 is moved downwardly, PA from passage 1720*b* can pass around valve 1722 between the lands thereof and through passage 1720*f* to the left-hand end of valve 1734. The latter is then moved to the right and this through link 1736 swings lever 1737 about the

axis of shaft 1738. Bar 1739 is thus moved by lever 1737 and cam surface 1740 acting on pin 1742 swings pawl 1743 out of engagement with lug 1745 thus releasing slide 1702 and thus the rammer. For manual operation, cam surface 1740 releases the slide as described. With valve 1734 thus moved to the right, PA can now pass from passage 1720*h*, around valve 1734, between the lands thereof, and through passage 1720*p* to the left-hand end of chamber 1720*k*. This PA will operate and pass check valve 1749. The check valve is closed on the ramming stroke, but permits fluid to enter the end of chamber 1720*k* on retraction of the rammer. There is now PA on both sides of valve 1752. Due to the greater area at its free end, said valve will be moved to the right, as shown in FIG. 107, thus moving portion 1752*a* and moving gear 1754 in mesh with racks 1756 and 1757. Since rack 1756 is stationary, this causes movement of rack 1757 and the slide 1702 to the right or rearwardly. The PA at the right of valve 1752 times the speed of movement of valve 1752 or portion 1752*a*. The rammer is thus moved rearwardly or retracted. When it reaches its limit of movement rearwardly, arm 1711 (see FIGS. 100 and 101) as above described engages member 1712, thus swinging shaft 1709 and moving pawl 1708 out of recess 1700*c*. The spade is now free to move downwardly and is moved downwardly by gravity and spring 1704. Swtich 1R2A indicating that the rammer is fully retracted, is actuated. Switch IR4A is actuated indicating that spade 1700 is completely down. Switch IR5A is also actuated by spring 1786 indicating that the spade is unlatched and down. As valve 1752 moves to the right, the liquid in chamber 1720*k* passes out through passage 1720*j* and can rejoin the incoming PA flow in valve chamber 1720*g*. Switch IR1ABC is actuated when the rammer has been retracted twelve inches or more and indicates that the gun has fired. Switch IR3A,B,C,D closes when the rammer is within ten inches of completing its ramming stroke so that the transfer tray can swing into discharge position.

When the spade is raised by the breech block, spring 1704 is raised by collar 1700*b*1 and compressed against collar 1704*a*. Collar 1700*b*1 also raises and compresses spring 1715*e*. This lifts rod 1715 and the groove 1715*d* in the head at its upper end is brought into horizontal alignment with pin 1767. When the rammer is fully retracted, pin 1767 is disposed in groove 1715*d*. When latch 1708 is released, spring 1704 pushes collar 1715*a* and the spade downwardly. Collar 1700*b*1 engages collar 1715*a* and rod 1715 is pulled downwardly. Groove 1715*d* acts as a cam and moves pin 1767 rearwardly, thus swinging lever 1762 and actuating switch IR4A. Switch IR4A then indicates that the rammer is fully retracted and unlatched, and that the spade is down.

It will thus be seen that the rammer is moved forwardly and rams the round into the gun by engaging the end of the powder case. The impact of the rammer with the powder case is cushioned, as stated, by the movement of the plunger 1701 and the rammer engages the gun housing and is stopped. The breech block is then moved upwardly and moves the spade 1700 upwardly to the position shown in FIG. 107, and said spade is latched in its upper position. Solenoid SR2 is then actuated as described, and the rammer including the spade 1700 and slide 1702 is moved rearwardly, as described, by valve 1752. The spade is released and again moves downwardly so that it is again in position to be moved forwardly in its ramming operation.

BREECH BLOCK MECHANISM

Referring to FIGS. 108–110, a breech block for the gun is shown as 1560. Said breech block is moved vertically into a firing or breech-closing position and to a ram or inoperative position. Block 1560 has a slight upward taper and when in firing position is wedged between a surface 11*a* of the gun housing 11 and the rear surface of the powder case. The rim of the powder case is between the block and the rear surface of the gun. A link 1565 is pivotally connected to the lower portion of block 1560 by the pivot pin 1566, the upper portion of said link moving in a recess 1560*a* in the bottom of the breech block. Link 1565 is pivotally connected by a pin 1567 to a lever 1568 which is swingable about a shaft 1570 carried in the outer end portion of bracket 1571 projecting from a valve block 1572 movable with the gun in its recoil and counter-recoil movement. Lever 1568 is generally of triangular shape and has pivoted adjacent one side thereof by a pin 1574, a link 1573. Link 1573 is pivotally connected at its other end by a pin 1576 to a valve rod 1578*a* of a valve 1578 movable in a valve chamber 1572*a* of valve block 1572. Shaft 1570 has secured thereto a cam 1580 having at one side an arm 1580*a* adapted in one position of said cam to actuate a switch IW7A and in another position of said cam to actuate a switch IW1A,B,C. Said cam 1580 also has a cam surface 1580*b* adapted in the movement of said cam to actuate a switch IW4A,B, which switch has an actuating arm IW4A,B*a* carrying a roller adapted to engage the cam surface 1580*b*.

A piston valve 1578 reciprocates in valve block 1572 and this moves valve rod 1578*a* and swings lever 1568 from the position shown in full lines in FIG. 108 to the dotted line position shown in said figure and this pulls down upon link 1565 and lowers the breech block. Valve 1578 has a reduced portion 1578*a*1 which projects through the front end of block 1572 and is connected by a link 1582 to a valve rod 1584*a* of a piston 1584 movable in a chamber 1572*c* of block 1572. Piston 1584 has a rod 1584*b* which projects through the front end of block 1572.

Valve 1578 has an axial recess therein adjacent rod 1578*a*1 in which is disposed a valve 1586. Valve 1586 has a beveled front surface which engages a surface on an annular portion 1578*b* of valve 1578, which portion 1578 surrounds an opening 1578*c* in valve 1578. Valve 1586 is held against said surface by a compression coiled spring 1585. A plurality of radial passages 1578*d* extend from the opening or chamber 1578*c* to the outer cylindrical surface of valve 1578. A plurality of passages 1578*e* extend from the rear end of valve 1578 to an annular chamber 1578*f* surrounding valve 1586 at its rear end. Valve 1586 has an axial bore or chamber 1578*g* therein from which extend a plurality of radial passages 1578*h*, said last mentioned passages extending to chamber 1578*f* and thus communicating with passages 1578*e*. Valve block 1572 has an annular chamber 1572*d* extending about the rear end of valve chamber 1572*a*. Said block also has therein a valve chamber 1572*e* in one part of which is disposed a valve 1587 having a flaring open rear end with which engages a beveled valve 1588 moved into such engagement by a compression coiled spring 1589, the other end of which engages one end of valve chamber 1572*e*. A number of small passages 1588*a* extend along the beveled surface of valve 1588. Valve 1587 has an axial chamber therein and a plurality of passages 1587*a* extend from said chamber to the exterior of said valve. Valve 1587 also has a plurality of passages 1587*b* extending through the wall thereof at its front end. A passage 1572*g* connects valve chamber 1572*e* to the annular chamber 1572*d* and thus to valve chamber 1572*a*. A conduit and passage 1591 extends from the front end of valve chamber 1572*e* to a valve block 1592 which is movable with the gun in its recoil and counter-recoil. A conduit and passage 1593 extends from one end of valve chamber 1572*a* to a valve block 1595. There are a number of the valve blocks 1595 and in practice three of these have been used. Each valve block 1595 has therein a valve 1596 movable in a chamber 1595*a* of the block 1595 and said valve has a plunger 1596*a* projecting above the top of block 1595. Block 1595 has a portion with a top surface 1595*b* which is a short distance below the upper end of plungers 1596

when the latter are in their upper positions. In practice this distance has been approximately one-quarter of an inch. When the bottom of the breech block is in the plane of the upper ends of plungers **1596** in their upper positions, it is in ram position. Each valve **1595** has a small passage extending from the bottom thereof to adjacent its top from which small radial passages extend to an upper enlarged end of valve chamber **1595***a*. Blocks **1595** are so located that the plungers **1596** are engaged by the bottom of said block when the block is lowered. Passage and conduit **1593** also communicates with another passage and conduit **1593***a* which extends to a valve chamber **1597***a* in a valve block **1597** which also moves with the gun in its recoil and counter-recoil movement. Passage **1593** adjacent chamber **1572***a* has therein a chamber in which is disposed a check valve **1598**. Another passage **1600** extends from passage **1593** in block **1572** to and around chamber **1572***a* and to an annular chamber **1572***h* in block **1572**. A multiplicity of small passages **1572***i* extend from chamber **1572***h* to chamber **1572***a*.

Another passage and conduit **1572***j* extends from chamber **1572***d* to a valve chamber **1572***k* extending longitudinally and some distance in block **1572**. Passage **1572***j* has a chamber therein in which is disposed a check valve **1601**. A plunger **1603** is disposed in chamber **1572***k* and is connected at a point beyond block **1572** to the slide **12**. Chamber **1572***k* has an enlarged portion at its rear end connecting to the main portion by a beveled surface **1572***m*. Plunger **1603** has an enlarged portion **1603***b* at its rear end which fits in passage **1572***k* in the smaller part of said passage to the left of beveled portion **1572***m*, as seen in FIG. 110. Plunger **1603** has an axial passage **1603***a* extending therethrough and in practice this normally contains supercharge pressure which is in the operation of the block equivalent to being connected to tank. A passage and conduit **1572***n* extends between the ends of chamber **1572***k*, the same having therein a chamber in which is disposed a check valve **1604**. A passage **1605** connects to one end of passage **1572***n* and also connects with a valve chamber **1607***a* formed in a valve block **1607**, said chamber having an enlarged rear end. A valve **1608** is movable in the smaller end of chamber **1607***a* and is moved toward said end by a coiled compression spring **1609**. A passage **1607***b* extends from an annular chamber about valve **1608** to passage **1572***n*. A passage **1607***c* extends from passage **1607***b* to the enlarged end of valve chamber **1607***a*. Block **1607** and associated parts forms a relief valve. A conduit and passage **1572***o* extends from the rear end of chamber **1572***k* to a valve chamber **1592***f* in valve block **1592**. A conduit and passage **1610** extends from passage **1572***o* to and alongside the upper portion of valve chamber **1597***a*, the same having several branches opening into said chamber.

Valve block **1572** carries a portion having a chamber **1572***p* having a reduced portion in which fits and moves a pump plunger **1611** having an enlarged portion with a collar thereon engaged by a coiled compression spring **1612** disposed in an enlarged portion of chamber **1572***p* and acting to move plunger **1611** to the left, as shown in FIG. 110. Plunger **1611** projects from block **1572** and at its end is engaged by a roller carried on the lower end of a hand lever **1614** pivoted at **1615** in a bracket **1616** mounted on the gun slide **12**. A passage **1572***q* extends from chamber **1572***p* to a tank passage **1572***r*. A chamber is disposed in passage **1572***q* and contains a spring-pressed check valve **1617**. A passage **1572***s* extends from one end of chamber **1572***p* to the tank passage **1572***r* and contains a chamber in which is disposed a spring-pressed check valve **1619**. The passages **1572***q*, **1572***s*, and **1572***r* extend below the chamber **1572***p*, as shown in FIG. 108, to a valve chamber **1572***t*. Said passages each have a chamber below chamber **1572***p* in which are respectively disposed spring-pressed check valves **1620** and **1621**. Said latter check valves prevent the flow of liquid toward chamber **1572***p*. Valve chamber **1572***t* has passages leading from either side thereof which are adapted to be closed by spring-pressed check valves **1622** and **1623**. Passages **1572***u* and **1572***v* lead respectively from the chambers of valves **1622** and **1623** to the ends of valve chamber **1572***c*. A valve **1624** is rotatable in chamber **1572***t* and has portions adapted to close the ports at either side thereof or have said ports open.

Valve block **1592** has a chamber **1592***a* therein which is movable a valve **1625** urged to its upper position in said valve chamber by a compression coiled spring **1626**. Valve **1625** has a valve rod **1625***a* extending upwardly therefrom connected by a link **1627** to a bell crank lever **1629** pivoted to a bracket carried on the gun housing **11**. Lever **1629** also has connected thereto a link **1630** which is connected by a pivot **1631** to the powder case ejectors **1632**. Said ejectors **1632** have lips **1632***a* which are disposed in front of the powder case rim. Member **1631** carries a roller which moves in a slot **1628***a* of a bracket **1628** carried on the gun housing. The ejector **1632** has an arm **1632***b* carrying a cam roller **1632***c* which rolls on the top of bracket **1628** and assists in guiding the movement of ejector **1632**. There is an ejector **1632** at each side of the breech and thus at each side of the empty case. The breech block is provided with a recess **1560***b* in which are disposed the ejectors **1632**.

Block **1592** also has therein a valve chamber **1592***b* in which is disposed a valve casing **1636**. A valve **1634** is movable in casing **1636** and is moved to its upper position by a compression coiled spring **1635**. Casing **1636** has a central opening at its top above valve **1634** and has annular ports **1636***a* and **1636***b* in the sides thereof with which valve **1634** cooperates. A passage **1592***c* extends from port **1636***a* to the upper end of valve chamber **1592***a*. A passage **1592***d* extends from the lower portion of port **1636***a* to the lower end of valve chamber **1592***a*. A passage **1592***e* extends from the upper end of valve chamber **1592***b* to a valve chamber **1592***f* in which is disposed a valve **1637**, which valve is moved to its upper position by a compression coiled spring **1638**. A passage **1592***g* extends from the lower end of valve chamber **1592***a* to the bottom of valve chamber **1592***f* and also connects to passage **1572***o*. Passage **1572***o* extends to and communicates with chamber **1592***f*. Valve **1637** has an upper portion **1637***a* projecting from block **1592** and adapted to be engaged by the bottom of the breech block when the latter is lowered.

A passage **1592***h* extends from passage **1572***o* to a valve chamber **1592***i* in block **1592**. A valve **1640** is disposed in and movable in chamber **1592***i*, the same having a rod at its upper end having therein spaced detent grooves **1640***a* either of which is adapted to receive a spring pressed detent **1641** for holding valve **1640** in different positions. It will be noted that conduit and passage **1591** communicates with valve chamber **1592***i* adjacent the upper portion thereof. Valve **1640** has connected to the upper end of the rod extending therefrom a link **1642** in turn connected to a bell crank lever **1643** pivoted to a bracket **1644** secured to the gun housing **11**. A lever **1645** is pivoted intermediate its ends to a lug carried on the rammer guide by a pivot **1646** and has an upper portion engaged by a coiled torsion spring **1647**. Lever **1645** is held in the position shown in FIG. 108 by spring **1647** and is adapted to be engaged by the rammer spade when the latter moves to ramming position. Lever **1645** has a lower portion adapted to engage a roller **1648** carried on one arm of the bell crank lever **1643**.

Valve **1625** has a valve rod depending therefrom through the bottom of block **1592**, the same being connected by a link **1650** to one end of a lever **1651** pivoted at its opposite end to a bracket **1652** carried on the

gun housing **11**. Valve **1640** has a yoke **1640***b* embracing said lever so that when valve **1625** moves downwardly, lever **1651** can engage yoke **1640***b* and move valve **1640** downwardly.

A passage **1592***j* extends from the lower portion of valve chamber **1592***f* to the upper portion of valve chamber **1592***i*. A conduit and passage **1592***k* extends from the upper end of passage **1592***j* to an intermediate point in valve chamber **1597***a*. A passage and conduit **1592***m* extends from valve chamber **1592***i* at a point below the upper end of passage **1592***j* to chamber **1597***a* below passage **1592***k*. It will be noted that passage **1610** extending from passage **1572***o* extends along the side of valve chamber **1597***a* and has several ports communicating with said valve chamber. A passage **1597***b* extends from one side of valve chamber **1597***a* and will be connected to accumulator pressure or PA. Passage **1597***b* has therein a chamber in which is disposed a check valve **1654** preventing passage of fluid outwardly from chamber **1597***a* through passage **1597***b*. An arm **1653** which moves with lever **1651** about pivot **1652***a* has connected thereto a link **1656** which is in turn connected to a cylindrical shell **1657** slidable in a bore in an extension of valve block **1597**. Member **1657** is bored to receive the cylindrical end of a detent member **1658** which has a front detent portion adapted to enter a recess **1660***a* in a valve **1660** which is movable in chamber **1597***a*. Member **1658** is urged to move toward valve **1660** and into recess **1660***a* when possible by a compression coiled spring **1661**. Member **1658** has an elongated slot **1658***a* therein in which is movable a pin **1662** secured to member **1657**. When valve **1625** is moved downwardly and lever **1651** is swung about pivot **1652***a*, arm **1652** will be swung counter-clockwise, as shown in FIG. 108 and pin **1662** will be moved to the end of slot **1658***a* so that the detent member **1658** will be held in withdrawn position. When valve **1625** is in its upper position, as shown in FIG. 108, detent **1658** can enter the recess **1660***a* when said recess aligns with member **1658**. Valve **1660** is urged to its upper position by a compression coiled spring **1663** engaging the lower end of said valve and the bottom of valve chamber **1597***a*. Valve **1660** has a roller **1665** at its upper end which is urged against the bottom of a portion of the slide **12** which contains a downwardly sloping cam portion **12***g*.

A hand lever **1666** is swingable about a pivot **1665** in a bracket **1668** carried on slide **12** and lever **1666** extends below said bracket and is pivotally connected adjacent its lower end to a link **1669** which at its other end is pivotally connected to one arm of a bell crank lever **1670**. The other arm **1670***a* of said lever is disposed in position to engage roller **1665** at the top of valve **1660**. A latch **1666***a* is spring-pressed to latching position, as seen in FIG. 109, and has a knob at one end for moving it to unlatching position. Latch **1667** is extended to operate a switch IWBA. When lever **1666** is unlatched for movement, switch IWBA is moved to position to prevent a rammer operation, which operation would at such time cause damage.

A pair of switches IW2A,B and IW3A,B are shown above the gun housing **11** spaced in the direction of recoil. Said switches have actuating arms which carry rollers adapted to be engaged by the cam surface **11***c* when counter-recoil occurs. Said switches will thus indicate respectively how far the gun is from battery.

Operation of breech block

Assuming that the breech block is in upper breech closing position, as shown in FIG. 108, a cycle of operation to lower the block occurs as follows. The gun is fired and recoil occurs and valve block **1597** is moved rearwardly with the gun as are also valve blocks **1592** and **1572**. As roller **1665** is moved rearwardly it is moved down by cam surface **12***g* and this depresses valve **1660**. Detent member **1658** enters recess **1660***a* and holds valve **1660** in this depressed position. PA can now pass from passage **1597***b* around valve **1660**, between the upper two lands thereof, through passage **1592***k*, around valve **1640**, between the upper two lands thereof, into passage **1591**, through valve chamber **1572***e*, through port **1572***g*, chamber **1572***d* and passages **1578***d* to the right-hand end of valve **1578**. Valve **1588***a* is moved rearwardly against the pressure of spring **1589** by this pressure so that a free passage is had to passage **1572***g*. When valve **1578** is moved to the left, as shown in FIG. 110, in lowering the block it will cut off passage **1600** when it approaches the end of its movement. The fluid must then pass out through the small passages **1572***i* into annular chamber **1592***h* and through passage **1600**. This will give a buffing effect or decelerating movement to the valve and to the block **1560**. The PA moves valve **1578** to the left, as shown in FIG. 110. This will move rod **1578***a* and swing lever **1578** to pull down on block **1560** by the link **1565** and the breech block is lowered.

When recoil occurs, valve block **1572** is moved to the right, as shown in FIG. 110, and thus moves relatively to plunger **1603**. When the enlarged portion **1603***b* of plunger **1603** enters the smaller part of chamber **1572***k*, the fluid in said chamber is moved by said plunger and passes out through passage **1572***j*, around check valve **1601** and into the annular passage **1572***d* and thus to the right-hand end of valve **1578**, as seen in FIG. 110. Thus both pressure formed by recoil and PA are placed on valve **1578**. The recoil pressure rises to a much higher figure than the PA. Both are used to be sure to swing lever **1568** and break the toggle formed by said lever and link **1565** and to break the breech block **1560** loose and pull the same downwardly. Lever **1568** is thus swung and the breech block is moved downward.

It will be noted that the fluid forced out of chamber **1572***k* cannot go into passage **1572***n* on account of check valve **1604**. It can go into passage **1605** and into chamber **1607***a*. Should the pressure rise sufficiently to move valve **1608** to the right a sufficient distance, the fluid can then move through passage **1607***b*, into passage **1572***n*, into chamber **1572***k* and out through passage **1603***a* to supercharge or tank. Valve **1608** is thus merely a relief valve to control the maximum pressure.

As stated, the bottom of the block engages the plungers **1596** and moves these plungers down against PC or supercharge pressure which is approximately 200 pounds per square inch. The block is thus cushioned or buffed and continues downwardly until it reaches and engages the surfaces **1595***b*. The valve blocks **1595** and plungers **1596** were provided to prevent any bouncing of the breech block when it moves to its lower position. In the first operation of the mount, considerable trouble was encountered due to a bouncing action of the breech block when it reached its ram position. The time cycle of the block in its lowering movement is .06 of a second. The problem presented was solved by the provision of plungers **1596**.

When the breech block is thus moved downward, it engages the top of portion **1637***a* and moves valve **1637** downwardly. As stated, PA is now in passage **1592***k* and the same now passes through passage **1592***j*, around valve **1637**, between the lands thereof, into passage **1592***e* and to the upper end of valve **1634**. Valve **1634** is moved downwardly into shell **1636** and when it moves down sufficiently, PA can pass freely through the upper central opening in shell **1636** and through port **1636***a* and passage **1592***c* to the upper end of valve **1625**. Valve **1625** is now moved downwardly, pulling down upon link **1627** and swinging lever **1629**. Lever **1629** pulls upon link **1630** and this swings the ejectors **1632** and pulls or ejects the empty powder case from the breech of the gun, which powder case is discharged into the empty case tray. When valve **1625** doves downwardly, it moves the end of lever **1651** downwardly, which lever engages the yoke **1640***b* and moves the same downwardly, thus mov-

ing valve **1640** downwardly. Detent **1641** will now enter the upper recess **1640***a*.

When lever **1651** is swung downwardly, arm **1652** is swung in a counter-clockwise direction and detent member **1658** is moved to the left, as shown in FIG. 108, releasing valve **1660** so that it will be raised by spring **1663** when not obstructed by cam surface **12***g*. As soon as there is sufficient recoil, valve **1660** will move up to the position shown in FIG. 108. PA can now pass from passage **1597***b*, around valve **1660**, between the lower lands thereof, through passage **1593***a* and pasage **1593**, into chamber **1595***a* of block **1595**. This pressure will now move plungers **1596** to their upper position, as shown in FIG. 108, and the bottom of the breech block **1560** will be moved from the plane of surfaces **1595** to the plane of the top surfaces of plungers **1596**. The breech block is now moved to ram position. However, the breech block is still held down by PA being at the right or rear end of valve **1578**.

When valve **1660** moved upwardly, PA was cut off from passage **1592***k* and PA was cut off from the top of valves **1636** and **1625**. Spring **1626** now moves valve **1625** upwardly, thus moving link **1627** and swinging lever **1629** and the ejectors **1632** to the position shown in FIG. 108. Ports **1636***a* and the lower part of valve chamber **1592***d* are now ported to supercharge or tank through passages **1592***g*, **1572***o* and **1603***a*. When PA is cut off from passage **1592***k*, as described, spring **1638** will move valve **1637** to its upper position.

The block is now, as stated, in ram position and the gun moves back into battery.

As the rammer moves forwardly to ram the next round into the breech, the rammer spade **1700** moving forwardly contacts level **1647** swinging the same in a counter-clockwise position about pivot **1646**. The lower end of lever **1647** engages roller **1648** on lever **1643** and said lever is swung in a clockwise direction, thus pulling up on link **1642** and lifting valve **1640** to its upper position, as shown in FIG. 108. Detent member **1658** is now released since valve **1625** is in its upper position and yoke **1640***b* is in its upper position. Said detent is thus in position to again enter recess **1660***a* when valve **1660** is depressed in the next recoil. When valve **1640** is moved to its upper position the fluid at the right-hand or rear end of valve **1578** can now pass through passages **1578***d*, chamber **1572***d*, chamber **1572***e*, passage **1591**, around valve **1640** between the lands thereof, through passage **1592***k*, around valve **1660**, through the port next to the top port from chamber **1597***a*, through passage **1610** and to chamber **1572***k*, and through passage **1603***a* to tank.

Also with valve **1660** in its upper position, PA can now pass through passage **1597***b*, around valve **1660** between the lower lands thereof, through passages **1593***a*, **1593** and into chamber **1572***a* at the front or left-hand of valve **1578**, as seen in FIG. 110. Valve **1578** is now moved to the right and lever **1568** is swung about its pivot **1570**, thus moving link **1565** upwardly and moving block **1560** to its upper position. As valve **1578** moves to its rearmost or right-hand position, as shown in FIG. 110, when the rearmost end part is beyond chamber **1572***d*, some liquid will be trapped. This will force valve **1586** to the left against the pressure of spring **1585** and give a buffing effect. It may be stated that when valve **1578** is moved rearwardly or to the right, the fluid at the right-hand end thereof passes out through passages **1578***d*, into annular chamber **1572***d* and through passage **1572***g* and passages **1587***a* and **1587***b* to conduit **1591**, then to valve chamber **1592***i*, around valve **1640** to conduit **1592***k*, around valve **1660**, through conduit **1610**, through conduit **1572***o* to valve chamber **1572***k* and through passage **1603***a* to PS or tank. When valve **1578** nears the end of its movement the fluid must go through passages **1572***e*, annular chamber **1572***d* and the small passages **1588***a*. This gives a buffing effect. The valve block **1560** is now again in its upper position and all parts have been brought to the position shown in FIGS. 108 and 110.

Apparatus is provided for manually operating the breech block. When it is desired to manually lower the block, lever **1666** will be swung to swing lever **1670** and depress valve **1660**. The operator can then operate lever **1614** and operate the pump plunger **1611**. If it is desired to lower the block, valve **1624** will be moved clockwise, as shown in FIG. 110, to bring line **1624***a* into coincidence with line **1624***b*. The port at the left-hand side of chamber **1572***t* will now be opened and the port at the right-hand side of said chamber will be closed. Operation of pump plunger **1611** will now force fluid past check valve **1621**, around valve **1623** and through passage **1572***v* to the right-hand end of valve **1584**. This valve will now be moved to the left, as shown in FIG. 110, and this will move rod **1584***a*, link **1582**, valve **1578**, rod **1578***a* and link **1573**, and will swing lever **1568** to pull down upon link **1565** and lower the block. The fluid at the left-hand side or front side of valve **1584** will pass out through passage **1572***u*, into the chamber of valve **1622**, and then through passage **1574***r* to the top of valve **1624** and out through said latter passage to tank. If it is desired to raise the block, valve **1624** will be moved counter-clockwise, as shown in FIG. 110 to bring line **1624***a* into coincidence with line **1624***c*. The port at the right-hand side of chamber **1572***t* will now be opened and the port at the left-hand side of said chamber will be closed. Reciprocation of plungers **1611** will now force liquid past the valve **1620**, into the chamber of valve **1622** and through passage **1572***u* to the front or left-hand side of valve **1584**. Valve **1584** will now be moved to the left, as shown in FIG. 110, and lever **1568** will be swung to move link **1565** upwardly and move the valve block **1560** to its upper position. The fluid at the right-hand side of valve **1584** can move through passage **1572***v*, into the chamber of valve **1623**, and then around the upper side of valve **1624** to tank passage **1572***r*. The breech block **1560** can thus be lowered and raised manually.

As previously described, the rammer spade has a buffing member **1701**. The rammer eventually engages the gun housing. Should the housing be too far out of battery proper buffing will not take place and the rammer will bang against the housing. Switch IW2AB prevents operation of the rammer until the gun is within one-half inch of battery. Switch IW3AB prevents the lowering of a transfer tray until the gun is within three and thirteen sixteenths of an inch from battery at which time the transfer tray will clear the gun housing.

THE EMPTY CASE EJECTOR

An empty case ejector mechanism is provided which cooperates with the empty case tray. This comprises an elongated conduit or chute **1450**, one end of which aligns with one end of the empty case tray **1400**, said conduit or chute curving upwardly and having its other end extending through the shield **1452** of the gun. (See FIGS. 111 to 113.) A member **1454** is provided which is provided with a splined bore which fits a splined shaft **1455** so that member **1454** is slidable on and guided on said shaft. Member **1454** has a guideway **1454***a* in its top portion in which fits and is slidable a casing or slide **1456**. The slide **1456** is of trough shape being open at its top and of general rectangular form in vertical cross section. Said slide has an end wall to which is pivoted, in suitable lugs by a pivot **1458**, a pawl **1460**. Pawl **1460** has a flat end which is adapted to engage the end wall of slide **1456**, as shown in FIG. 111. Pawl **1460** can swing downwardly but is urged to position engaging the end wall of slide **1456** by a compression coiled spring **1461** which seats in recesses in slide **1456** and pawl **1460**. Member **1454** has an extension at one end provided with a bore in which is disposed one end of a compression coiled spring **1462** which engages slide **1456** at its other end and urges slide **1456** to the position shown in FIG. 111. Member **1454**

therefrom communicating with a chamber **2228***b* formed in an extension of casing **2228**. A piston **2236** is movable in chamber **2228***b* and is moved toward valve **2230** by a coiled compression spring **2237**. Passages and conduits **2228***d* extend from valve chamber **2228***a* at each side of passage **2228***c* to a conduit **2228***e* leading to tank. A switch IRGABC has an actuating plunger arranged to be engaged by a stem projecting from valve **2236**.

A filter **2238** is provided from which a conduit or passage **2239** extends to a valve block **2240**. Valve block **2240** has a chamber **2240***a* therein and a passage **2240***b* leads from this chamber through another filter **2242** to a passage **2240***c* extending to the outer side of block **2240** and which is closed by a removable threaded plug **2244**. A valve **2245** is arranged to close or open the passage from conduit **2239** and another valve **2246** is arranged to open or close a passage **2240***d* leading to the atmosphere from chamber **2240***a*.

Operation of accumulator booster mechanism

In operation the parts other than those connected to the valve blocks **2228** and **2240** will occupy the position shown when the gun is in battery. When the gun is fired, the housing **11** will move to the right in its recoil movement, as shown in FIG. 118. Piston **2202***a* will move into the smaller portion of chamber **2204** and this movement will cause closing of the ball check valve **2206**. The fluid or oil in chamber **2204** to the right of piston **2202**a will be forced to the right in the recoil movement and will be forced out through passage **2207**, into conduit **2208**, and into the high pressure accumulator **2210**. Piston **2202***a* in moving to the right, as shown in FIG. 118, moves against PA pressure. This tends to decelerate the movement of the gun and other recoiling parts. As piston **2202***a* moves to the right, fluid will be drawn into chamber **2204** through passage **2212** and conduit **2212***a* and through the check valve **2215** which will now be opened. This fluid can pass from the low pressure accumulator **2214** through passage **2212***b* or from the PS in the empty powder case extractor and breech operating mechanism through passage and conduit **2212***a*.

When counter-recoil occurs, the gun housing **11** will move to the left, as shown in FIG. 118. The fluid which has filled the chamber **2204** at the left of piston **2202***a* will now be moved to the left by said piston **2202***a* and the same will pass through the bore **2202***c*, past check valve **2206**, out through passage **2202***d*, into the chamber **2204**, and out through passage **2207** and conduit **2208** to the high pressure accumulator **2210**. As piston **2202** moves to the left, fluid will be supplied into chamber **2204** through the conduits **2218** and **2218***a* from the PA line to the rammer, transfer trays, case ejector and fuse setter mechanism. It will be noted that valve **2215** will be closed by the force of the fluid when piston **2202** moves to the left. Fluid is thus forced under high pressure into the accumulator **2210** both on recoil and counter-recoil.

As stated, conduit **2216** leads to the low pressure pump and PS will be pumped through said conduit to the low pressure accumulator **2214**. When this pressure reaches a certain point, piston **2220** will be moved to the left, as shown in FIG. 118, and the passage **2214***f* will be uncovered. The fluid entering chamber **2214***a* can then by-pass into chamber **2214***e* to the header tank **2223**. When the small portion of piston **2220** passes plunger **2224**, the same will be moved into chamber **2214***e* by spring **2226** permitting operation of switch IR7A which will indicate that the low pressure accumulator is fully charged. When piston **2220** moves to the right, plunger **2224** will be cammed down to the position shown and again actuates switch IR7A. Said switch will then indicate that the low pressure accumulator is not fully charged.

The PA in line **2218** tends to move piston **2220** to the right, as shown in FIG. 118. This PA however acts against the small surface at the end of chamber **2220***a*. The low pressure accumulator pump forces fluid through conduit **2216***a* into chamber **2214***a* and against a large surface of piston **2220**. Piston **2220** can thus be moved and the PA in chamber **2220***a* merely forms a cushion for the low pressure accumulator and piston **2220**.

The accumulator pressure which is high pressure liquid from the accumulator **2210** or PA is supplied through conduit **2231** to chamber **2228***a*. This will move piston **2230** to the position shown in FIG. 118 against the resistance of spring **2234**. Should the PA pressure rise beyond a certain point, valve **2230** will be moved farther to the right, thus moving plunger **2233** so that passage **2228***d* will be uncovered and the fluid can then pass through said passage and through passage **2228***e* to tank. When valve **2230** thus moves to the right, PA can pass around the central portion of said valve and through passage **2228***c* and will move plunger **2236** upwardly against the resistance of spring **2237**. This will operate the switch IR6*ABC* and this will indicate that there is excessive pressure in the high pressure accumulator. As soon as the pressure is relieved to the desired point, spring **2234** will move valve **2230** back to the position shown, thus cutting off PA to plunger **2236**. Said plunger will now be moved down to the position shown by spring **2237**. Switch IR6ABC will again operate and will be in position to indicate that pressure in the accumulator **2210** is at the desired point.

It is desired to have a certain amount of air at one end of accumulator **2210**. If it is desired to supply air to said accumulator, plug **2244** will be removed and the air supply line connected into passage **2204***c*. Valve **2245** will be opened by a suitable wrench applied to the outer end thereof and air can then be forced through passages **2240***c*, **2240***b* and **2239**, through filters **2242** and **2238** into the accumulator. Should it be desired to reduce the air supply, valve **2245** will be opened, as will also valve **2246**. Air will then pass through filter **2238** and passage **2239** into chamber **2240***a* and out through passage **2240***d* to the atmosphere. When the air supply has been adjusted, valves **2245** and **2246** will of course be closed and plug **2244** again placed in position.

From the above description it will be seen that the energy of the recoil and counter-recoil of the gun is used to force liquid into the high pressure accumulator. It will thus be necessary to operate the high pressure pump for only a shorter period than if the energy of recoil and counter-recoil were not so used, which high pressure accumulator.

HEATING DEVICE FOR SHIELD

The present mount is provided with a shield **1452** of arcuate or semi-cylindrical form which moves with the gun. Said shield is shown in FIGS. 1 and 114 to 117. Shield **1452** is provided with an opening **1452***b* through which the gun and gun housing **11** project. Said shield also is provided with an opening **1452***c* over which is secured a casting **1552**. Member **1552** has hinged thereto a door **1518** which as already described closes the end of the discharge chute for the empty powder cases which chute projects through opening **1452***c*. When the vessel carrying the mount is in a rough sea, at low temperatures and under spray conditions, the spray will freeze on the shield and about the door **1518** and casting **1552**. This collection of ice is objectionable and the door **1518** is apt to freeze shut thus preventing the discharge of the empty powder cases. A novel means has been provided for keeping the shield **1452** and member **1552** at a temperature preventing objectionable accumulation of ice and preventing door **1518** from freezing shut.

A comparatively thin plate **1782** is provided and formed with V-shaped ribs **1782***a* which are pressed outwardly

at one side thereof. As shown in FIG. 115, ribs **1782***a* have portions **1782***b* which extend along and substantially parallel to the edges of plate **1782** and have other portions **1782***d* which extend transversely of plate **1782**. Portions **1782***d* are arranged in substantially parallel relation and have one end thereof connecting with portions **1782***b*. Alternate portions **1782***d* terminate short of the portion **1782** opposite that with which they connect. When plate **1782** is disposed with ribs **1782***a* against shield **1452**, a channel or passage **1782***c* is formed between said ribs, as indicated by the arrows in FIG. 117. This channel is formed by shield **1452**, plate **1782** and ribs **1782***a*. A pipe **1784** communicates with one end of passage **1782***c* while a pipe **1786** communicates with the other end of passage **1782***c*. Plate **1782** extends around the top of shield **1452**, as shown in FIG. 114, and a similar plate **1787** extends about the lower side of said shield. Plate **1787** is formed with ribs similar to plate **1782**. A passage is thus formed by the ribs in plate **1787** which are arranged similarly to the ribs **1782***a* in plate **1782**. A conduit **1788** communicates with one end of the passage formed in plate **1787** and is connected at its other end to the intake passage of a rotary pump **1790** which is driven by a motor **1791** secured to a portion of the gun housing. The discharge end of pump **1790** has connected thereto a conduit **1792**, the other end of which is connected to a heating and expansion tank **1793** suitably carried on the gun housing.

Tank **1793** has disposed therein a heating element **1794** which may be of the electrical type. Tank **1793** has therein a cylinder **1796** open at one end and having a piston **1797** fitting in and movable therein. Piston **1797** is moved toward the open end of cylinder **1796** by a coiled compression spring **1798** and said piston has secured thereto a rod **1800** which is guided in one end of tank **1793**. Any expansion of the liquid in tank **1793** can be taken care of by the movement of piston **1797**. Said piston will be moved by the liquid in tank **1793** against the pressure of spring **1798**.

The conduit **1784** is connected at its end opposite channel **1782***c* to tank **1793**. The conduit **1786** is connected to a member **1801** which has passages communicating with passages in the end **1552***d* of a casting **1552** so that the liquid circulates through said passages and then to a conduit **1803** which is connected to the other end of the passage formed in plate **1787**. After traversing said last mentioned passage, which is similar, as stated, to passage **1782***c*, the liquid again passes to conduit **1788** and thence to the pump **1790**.

A heated liquid is thus circulated from tank **1793**, through conduit **1784** to and through passage **1782***c*, then through conduit **1786** to member **1801** and the passages in the member **1552** adjacent door **1518**, then through the passage formed in plate **1787** and back to the pump **1790** and through conduit **1792** to the tank **1793**. The heating liquid can be held at the desired temperature and the shield and member **1552** will be maintained at a temperature well above freezing. Objectionable collection of ice on the shield is thus prevented and the member **1552** is kept heated so that there is no danger of door **1518** being frozen shut.

From the above description it will be seen that we have produced a novel and very efficient gun mount which operates through a remarkably short cycle. The mount is designed for a cycle of one and four tenths seconds. This is the time which elapses from the time the round is raised by the lower hoist until the gun is fired. When the mount is in power operation the only thing that is done manually is the placing of the projectiles and powder cases in the loader. The rotation of the projectile and powder drums, the operation of the lower hoist, the carrier, the upper hoist, the cradle, the transfer trays, the fuse pot mechanism, the rammer, the breech block mechanism, the empty case tray and the case ejecting mechanism operate automatically in sequence. The necessary switches are closed and the actuating solenoids operate in sequence as each one of the previous elements goes through its operation. As set forth in the description, certain switches must be operated before the next operation can take place. All of the operations are thus safeguarded so that there will be no interference.

The device has been amply tested in actual operation and found to be very successful. It has had long tests in the factory and has had a thorough test at the Navy proving grounds. The mount is now being produced in considerable numbers for the Navy.

It will of course be understood that various changes may be made in the form, details, arrangement and proportions of the parts, without departing from the scope of applicants' invention, which generally stated, consists in a device capable of carrying out the objects above set forth, in the parts and combinations of parts disclosed and defined in the appended claims.

What is claimed is:

1. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a magazine comprising a casing, an upper projectile-receiving drum rotatable in said casing having a plurality of projectile-receiving chambers therein, a lower powder case-receiving drum rotatable in said casing in axial alignment with said upper drum and having a plurality of powder case-receiving chambers therein, said casing having an opening therein, a pair of doors mounted at said opening with which said chambers in said upper drum align and through which a projectile may be pushed into one of said chambers, said casing having a second opening, a pair of doors at said second opening with which each of said chambers in said lower drum is adapted to align and through which a powder case may be pushed into one of said last mentioned chambers, a discharge passage for said projectiles and powder cases, and means for intermittently rotating said drums to bring the chambers thereof in respective alignment with said openings, doors and discharge passage.

2. The structure set forth in claim **1**, and means for preventing movement of said doors while said drum is being rotated.

3. The structure set forth in claim **1**, and means actuated when said doors are open for preventing rotation of said drum.

4. The structure set forth in claim **3**, and a member movable by the operator for rendering said last mentioned means inoperative.

5. The structure set forth in claim **1**, and means for locking said doors in different positions.

6. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a magazine comprising a casing, a projectile-receiving drum rotatable in said casing, a powder case-receiving drum rotatable in said casing below said first mentioned drum and in axial alignment therewith, said drums each having a plurality of circumferentially spaced chambers therein for receiving respectively a projectile and a powder case, a discharge passage in said casing for said projectiles and powder cases, and a hoist operating in said discharge passage for lifting said powder cases and projectiles and moving them vertically from said casing and drums.

7. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a magazine comprising a casing, an upper projectile-receiving drum rotatable in said casing and having a plurality of circumferentially spaced chambers each adapted to receive a projectile, a stationary support on which said projectiles are moved by said drum, a lower powder case-receiving drum rotatable in said casing and in axial alignment with said upper drum, the same having a plurality of circumferentially spaced chambers each adapted to receive a powder case, means at the bottom of each of said last mentioned chambers

for supporting a powder case, a hoist at the side of said casing having a passage with which said chambers align, for lifting and moving said powder cases and projectiles from said drums, means for rotating said drums for bringing one of each of said chambers with a projectile and a powder case therein respectively into said passage, a plate aligned with said passage onto which said projectile is moved, and means for swinging said plate away from said projectile to permit said projectile to rest on the top of said powder case in said passage.

8. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a magazine comprising a casing, an upper projectile-receiving drum rotatable in said casing and having a plurality of circumferentially spaced chambers each adapted to receive a projectile, a lower powder case-receiving drum rotatable in said casing and in axial alignment with said upper drum, the same having a plurality of circumferentially spaced chambers each adapted to receive a powder case, a hoist at the side of said casing having a passage with which said chambers are adapted to align so they can be lifted by said hoist, means for rotating said drums to bring one of each of said chambers thereof and a projectile and powder case respectively therein into said passage, said hoist being adapted to engage said powder case in said passage and move the same upwardly, a projectile-supporting member aligned with said passage onto which said projectile is moved, said member arranged to be engaged by said powder case and be moved away from said projectile to permit said projectile to move down and rest on the top of the powder case and be moved upwardly therewith by said hoist.

9. A gun mount for supporting a gun having in combination, means for supplying a round of ammunition to said gun, which round comprises a powder case and a projectile, including a magazine mechanism comprising a casing, a rotatable powder drum in said casing having circumferentially spaced chambers adapted respectively to receive powder cases, a rotatable projectile drum in said casing having circumferentially spaced chambers adapted respectively to receive spaced projectiles, said casing having openings therein, means for intermittently rotating said drums to bring said chambers in said drums respectively into alignment with said openings, a set of swinging shutters for each of said openings between which an operator can push a powder case and projectile into said chambers respectively, said shutters being engaged and swung by said powder case or projectile when the same are pushed into said drums, and means actuated when said shutters are swung by a powder case or projectile being pushed between the same to prevent rotating movement of said drums.

10. The structure set forth in claim 9, and a release member adapted to be moved by the operator after a powder case or projectile has been pushed into said drums respectively to render said last mentioned means inoperative and permit rotating movement of said drums.

11. A gun mount for supporting a gun having in combination, means for supplying a round of ammunition to said gun including a magazine device comprising a casing, a rotatable powder drum in said casing adapted to support a plurality of circumferentially spaced powder cases, a rotatable projectile drum in said casing above and axially aligned with said powder drum adapted to support a plurality of cirmuferentially spaced projectiles, a hoist passage at one side of said drums respectively, means for intermittently rotating said drums to bring powder cases and projectiles into axially aligned relation at said passage and a hoist member movable through said passage to move said powder cases and projectiles from said drums.

12. The structure set forth in claim 9, said shutters normally extending inwardly in converging relation, means causing one shutter to swing inwardly simultaneously with the other when the latter is swung inwardly, and resilient means for returning said shutters to normal position.

13. A gun mount for supporting a gun having in combination, a magazine device comprising a rotatable drum having a number of circumferentially spaced means for receiving ammunition units respectively, a discharge passage in said drum for said ammunition units, means for indexing said drum to align said circumferentially spaced means with said discharge passage, said indexing means including a gear operatively connected to said drum for rotating the same, a shaft for rotating said gear, a sleeve revoluble on said shaft and connected to said drum, means for rotating said sleeve, a stationary clutch member, a movable clutch member secured to said shaft adapted to engage said sleeve for rotating said drum and also to engage said stationary clutch member for holding said shaft and drum stationary.

14. The structure set forth in claim 13, said movable clutch being disposed relatively to said stationary clutch member and sleeve so as to engage said sleeve before it disengages said stationary clutch member whereby said shaft and drum are either connected to said sleeve so as to be rotated or are locked in stationary position.

15. The structure set forth in claim 13, said means for rotating said sleeve comprising a gear on said sleeve, a rack engaging said last mentioned gear, and means for reciprocating said rack whereby said rack is moved in one direction to rotate said drum with said sleeve clutched to said shaft and is moved in the opposite direction with said sleeve rotatable on said shaft and said shaft held in stationary position whereby said sleeve rotates on said shaft without rotating said drum.

16. The structure set forth in claim 15, said rack being connected to and reciprocated by a reciprocating piston, a chamber in which said piston is movable, and means for supplying fluid under pressure to said chamber for operating said piston.

17. The structure set forth in claim 13, cams on said sleeve and switches respectively operated by said cams for indicating the positions of said rack.

18. The structure set forth in claim 13, means for operating said movable clutch to engage said sleeve and drive said drum and to disengage said sleeve and engage said stationary clutch member, said last mentioned means comprising a lever and linkage mechanis, a piston connected to said mechanism for operating the same, a chamber in which said piston is movable, and means for supplying fluid under pressure to said chamber for operating said piston.

19. A gun mount for supporting a gun having in combination, a magazine device including a casing, a drum in said casing having circumferentially spaced means for respectively receiving units of ammunition, said casing having doors through which a unit of ammunition is supplied to said drum, means for locking said doors in fixed position, means for rotating said drum to bring one of said units into a certain position including a piston and a rack secured thereto, operated by fluid under pressure and movable to forward and retracted positions, a valve for controlling said fluid and the operation of said piston, a solenoid for actuating said valve, an electrical switch for indicating that there is no unit at said fixed position, a switch indicating that said doors are in locked position, a switch indicating that said rack is fully retracted, said solenoid being operated when said switches are operated to move said valve and cause operation of said piston and rack for rotating said drum.

20. The structure set forth in claim 19, means controlling and decelerating said rack, a switch actuated when said rack reaches its limit of movement, a second solenoid and means actuated when said last mentioned switch is actuated for operating said second solenoid and moving said valve to its original position for causing movement of said piston and retraction of said rack.

21. A gun mount for supporting a gun having in combination, means supplying ammunition to said gun including a magazine device comprising a pair of casings having a pair of drums rotatively mounted in each casing, said drums being adapted to receive a plurality of projectiles and powder cases in circumferentially spaced positions, a discharge passage in each of said casings, a lower hoist having spaced tubes disposed at the sides respectively of said casings and communicating with said discharge passages, each of which receives a projectile and powder case from said casings respectively, and a rotatable carrier above said hoist having chambers at opposite sides thereof into each of which chambers a projectile and powder case are respectively delivered from said tubes by said hoists.

22. The structure set forth in claim 21, means for rotating said carrier, and means for latching said carrier in stationary position with said tubes respectively aligned with said chambers in said carrier when a projectile and powder case are to be delivered to each of said chambers respectively from said hoist.

23. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a lower hoist having a stationary casing with a passage therein for receiving a unit of ammunition, a carrier above said hoist rotatable in opposite directions having a chamber for receiving a unit of ammunition from said lower hoist, means for rotating said carrier to bring said chamber into alignment with said passage, and means for selecting the direction of rotation of said carrier which will bring said chamber and passage into such alignment in the shortest time period regardless of the initial relative circumferential positions of said hoist and carrier.

24. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a lower hoist having a pair of spaced tubes through which units of ammunition are moved, a carrier above said hoist rotatable in opposite directions having a pair of chambers spaced 180 degrees apart adapted respectively to align with said tubes and to receive said units from said tubes, an upper hoist adjacent said carrier having a pair of tubes spaced 180 degrees apart adapted to align with said chambers for receiving said units respectively, said upper hoist being movable to different positions, means for rotating said carrier to bring said chambers thereof into alignment with either the tubes of said lower hoist or the tubes of said upper hoist, and means for determining the direction of rotation of said carrier so that said chambers of said carrier move into alignment with the tubes of said lower hoist or upper hoist respectively in the shortest period of time.

25. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a rotatable upper hoist having a passage for receiving a unit of ammunition, a carrier adjacent said hoist and rotatable in opposite directions, said carrier having a chamber for receiving a unit of ammunition, means for rotating said carrier to bring said chamber into alignment with said passage, and means for selecting the direction of rotation of said carrier to bring said chamber into alignment with said passage in the shortest period of time regardless of the movement or position of said upper hoist and passage.

26. A gun mount for supporting a gun for movement in train and in elevation having in combination, means for rotating said gun to provide training movement, means for supplying ammunition to said gun including a lower hoist having a stationary casing with a passage for receiving a unit of ammunition, a carrier adjacent said hoist rotatable in opposite directions and having a chamber for receiving said unit from said hoist, an upper hoist adjacent said carrier rotatable with said gun as it moves in train and having a passage for receiving said unit, means for rotating said carrier from a position with said chamber aligned with said last mentioned passage to a position with said chamber aligned with said first mentioned passage, and means for selecting the direction of rotation of said carrier which will bring said carrier to said latter position in the shortest period of time.

27. A gun mount for supporting a gun for movement in train and in elevation having in combination, means for rotating said gun about a vertical axis in different directions to provide training movement, means for supplying ammunition to said gun including a lower hoist having a stationary casing with a passage for receiving a unit of ammunition, a rotatable carrier above said hoist having a chamber for receiving said unit from said passage, an upper hoist adjacent said carrier rotatable with said gun as it moves in train and having a passage for receiving said unit, means for rotating said carrier from a position with said chamber aligned with said first mentioned passage to a position with said chamber aligned with said last mentioned passage, and means for selecting the direction of rotation which will bring said carrier to said latter position in the shortest period of time whether said upper hoist is moving in either direction or is stationary.

28. A gun mount for supporting a gun having in combination, a fluid-operated motor for moving said gun to provide training movement, a pump for supplying fluid under pressure to said motor, a member movable to vary the discharge of said pump to vary the speed and direction of rotation of said motor, a lower hoist having a stationary tube for receiving a unit of ammunition, a rotatable carrier having a chamber adapted to receive said unit and movable to a position with said chamber aligned with said tube to receive said unit, a second member movable with said gun in its training movement, said carrier being mounted on said member and rotatable relatively thereto, a second fluid-operated motor for rotating said carrier, a control mechanism for said second motor comprising a differential gear assembly, means for driving said assembly rotated in synchronism with the speed of said first mentioned motor, means for driving said assembly rotated in synchronism with said second motor, a third member moved by said assembly constituting the output of said assembly, a second differential gear assembly, means for driving said second assembly in synchronism with said third member, means for operating said second assembly in synchronism with the movement of said first mentioned members, a fourth member moved by said second assembly and constituting the output member thereof, and means actuated by said fourth member for controlling the rotation of said carrier whereby compensation is had to hold said carrier stationary when said chamber is aligned with said lower hoist tube while said gun is moving in train.

29. A gun mount for supporting a gun having in combination, means for rotating said gun about a vertical axis to provide training movement, a lower hoist having a stationary passage for receiving a unit of ammunition, a rotatable carrier above said hoist having a chamber for receiving said unit, an upper hoist adjacent said carrier rotatable with said gun about said axis and having a passage for receiving said unit, a fluid-operated motor for rotating said carrier to bring said chamber into alignment with either of said passages respectively, a valve casing, a valve movable in said casing, conduits connecting said valve casing and said motor, means for supplying fluid under pressure to said valve casing for moving said valve to different positions, said valve in one position causing said fluid to rotate said motor in one direction and in another position causing said fluid to rotate said motor in the opposite direction, a second valve casing, connections from said second valve casing to said first mentioned valve casing, a second valve in said second valve casing, and means for supplying fluid under pressure to said second valve casing for moving said second valve to positions for controlling said first mentioned valve and moving the same to positions

for supporting a powder case, a hoist at the side of said casing having a passage with which said chambers align, for lifting and moving said powder cases and projectiles from said drums, means for rotating said drums for bringing one of each of said chambers with a projectile and a powder case therein respectively into said passage, a plate aligned with said passage onto which said projectile is moved, and means for swinging said plate away from said projectile to permit said projectile to rest on the top of said powder case in said passage.

8. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a magazine comprising a casing, an upper projectile-receiving drum rotatable in said casing and having a plurality of circumferentially spaced chambers each adapted to receive a projectile, a lower powder case-receiving drum rotatable in said casing and in axial alignment with said upper drum, the same having a plurality of circumferentially spaced chambers each adapted to receive a powder case, a hoist at the side of said casing having a passage with which said chambers are adapted to align so they can be lifted by said hoist, means for rotating said drums to bring one of each of said chambers thereof and a projectile and powder case respectively therein into said passage, said hoist being adapted to engage said powder case in said passage and move the same upwardly, a projectile-supporting member aligned with said passage onto which said projectile is moved, said member arranged to be engaged by said powder case and be moved away from said projectile to permit said projectile to move down and rest on the top of the powder case and be moved upwardly therewith by said hoist.

9. A gun mount for supporting a gun having in combination, means for supplying a round of ammunition to said gun, which round comprises a powder case and a projectile, including a magazine mechanism comprising a casing, a rotatable powder drum in said casing having circumferentially spaced chambers adapted respectively to receive powder cases, a rotatable projectile drum in said casing having circumferentially spaced chambers adapted respectively to receive spaced projectiles, said casing having openings therein, means for intermittently rotating said drums to bring said chambers in said drums respectively into alignment with said openings, a set of swinging shutters for each of said openings between which an operator can push a powder case and projectile into said chambers respectively, said shutters being engaged and swung by said powder case or projectile when the same are pushed into said drums, and means actuated when said shutters are swung by a powder case or projectile being pushed between the same to prevent rotating movement of said drums.

10. The structure set forth in claim 9, and a release member adapted to be moved by the operator after a powder case or projectile has been pushed into said drums respectively to render said last mentioned means inoperative and permit rotating movement of said drums.

11. A gun mount for supporting a gun having in combination, means for supplying a round of ammunition to said gun including a magazine device comprising a casing, a rotatable powder drum in said casing adapted to support a plurality of circumferentially spaced powder cases, a rotatable projectile drum in said casing above and axially aligned with said powder drum adapted to support a plurality of cirmuferentially spaced projectiles, a hoist passage at one side of said drums respectively, means for intermittently rotating said drums to bring powder cases and projectiles into axially aligned relation at said passage and a hoist member movable through said passage to move said powder cases and projectiles from said drums.

12. The structure set forth in claim 9, said shutters normally extending inwardly in converging relation, means causing one shutter to swing inwardly simultaneously with the other when the latter is swung inwardly, and resilient means for returning said shutters to normal position.

13. A gun mount for supporting a gun having in combination, a magazine device comprising a rotatable drum having a number of circumferentially spaced means for receiving ammunition units respectively, a discharge passage in said drum for said ammunition units, means for indexing said drum to align said circumferentially spaced means with said discharge passage, said indexing means including a gear operatively connected to said drum for rotating the same, a shaft for rotating said gear, a sleeve revoluble on said shaft and connected to said drum, means for rotating said sleeve, a stationary clutch member, a movable clutch member secured to said shaft adapted to engage said sleeve for rotating said drum and also to engage said stationary clutch member for holding said shaft and drum stationary.

14. The structure set forth in claim 13, said movable clutch being disposed relatively to said stationary clutch member and sleeve so as to engage said sleeve before it disengages said stationary clutch member whereby said shaft and drum are either connected to said sleeve so as to be rotated or are locked in stationary position.

15. The structure set forth in claim 13, said means for rotating said sleeve comprising a gear on said sleeve, a rack engaging said last mentioned gear, and means for reciprocating said rack whereby said rack is moved in one direction to rotate said drum with said sleeve clutched to said shaft and is moved in the opposite direction with said sleeve rotatable on said shaft and said shaft held in stationary position whereby said sleeve rotates on said shaft without rotating said drum.

16. The structure set forth in claim 15, said rack being connected to and reciprocated by a reciprocating piston, a chamber in which said piston is movable, and means for supplying fluid under pressure to said chamber for operating said piston.

17. The structure set forth in claim 13, cams on said sleeve and switches respectively operated by said cams for indicating the positions of said rack.

18. The structure set forth in claim 13, means for operating said movable clutch to engage said sleeve and drive said drum and to disengage said sleeve and engage said stationary clutch member, said last mentioned means comprising a lever and linkage mechanis, a piston connected to said mechanism for operating the same, a chamber in which said piston is movable, and means for supplying fluid under pressure to said chamber for operating said piston.

19. A gun mount for supporting a gun having in combination, a magazine device including a casing, a drum in said casing having circumferentially spaced means for respectively receiving units of ammunition, said casing having doors through which a unit of ammunition is supplied to said drum, means for locking said doors in fixed position, means for rotating said drum to bring one of said units into a certain position including a piston and a rack secured thereto, operated by fluid under pressure and movable to forward and retracted positions, a valve for controlling said fluid and the operation of said piston, a solenoid for actuating said valve, an electrical switch for indicating that there is no unit at said fixed position, a switch indicating that said doors are in locked position, a switch indicating that said rack is fully retracted, said solenoid being operated when said switches are operated to move said valve and cause operation of said piston and rack for rotating said drum.

20. The structure set forth in claim 19, means controlling and decelerating said rack, a switch actuated when said rack reaches its limit of movement, a second solenoid and means actuated when said last mentioned switch is actuated for operating said second solenoid and moving said valve to its original position for causing movement of said piston and retraction of said rack.

21. A gun mount for supporting a gun having in combination, means supplying ammunition to said gun including a magazine device comprising a pair of casings having a pair of drums rotatively mounted in each casing, said drums being adapted to receive a plurality of projectiles and powder cases in circumferentially spaced positions, a discharge passage in each of said casings, a lower hoist having spaced tubes disposed at the sides respectively of said casings and communicating with said discharge passages, each of which receives a projectile and powder case from said casings respectively, and a rotatable carrier above said hoist having chambers at opposite sides thereof into each of which chambers a projectile and powder case are respectively delivered from said tubes by said hoists.

22. The structure set forth in claim 21, means for rotating said carrier, and means for latching said carrier in stationary position with said tubes respectively aligned with said chambers in said carrier when a projectile and powder case are to be delivered to each of said chambers respectively from said hoist.

23. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a lower hoist having a stationary casing with a passage therein for receiving a unit of ammunition, a carrier above said hoist rotatable in opposite directions having a chamber for receiving a unit of ammunition from said lower hoist, means for rotating said carrier to bring said chamber into alignment with said passage, and means for selecting the direction of rotation of said carrier which will bring said chamber and passage into such alignment in the shortest time period regardless of the initial relative circumferential positions of said hoist and carrier.

24. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a lower hoist having a pair of spaced tubes through which units of ammunition are moved, a carrier above said hoist rotatable in opposite directions having a pair of chambers spaced 180 degrees apart adapted respectively to align with said tubes and to receive said units from said tubes, an upper hoist adjacent said carrier having a pair of tubes spaced 180 degrees apart adapted to align with said chambers for receiving said units respectively, said upper hoist being movable to different positions, means for rotating said carrier to bring said chambers thereof into alignment with either the tubes of said lower hoist or the tubes of said upper hoist, and means for determining the direction of rotation of said carrier so that said chambers of said carrier move into alignment with the tubes of said lower hoist or upper hoist respectively in the shortest period of time.

25. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including a rotatable upper hoist having a passage for receiving a unit of ammunition, a carrier adjacent said hoist and rotatable in opposite directions, said carrier having a chamber for receiving a unit of ammunition, means for rotating said carrier to bring said chamber into alignment with said passage, and means for selecting the direction of rotation of said carrier to bring said chamber into alignment with said passage in the shortest period of time regardless of the movement or position of said upper hoist and passage.

26. A gun mount for supporting a gun for movement in train and in elevation having in combination, means for rotating said gun to provide training movement, means for supplying ammunition to said gun including a lower hoist having a stationary casing with a passage for receiving a unit of ammunition, a carrier adjacent said hoist rotatable in opposite directions and having a chamber for receiving said unit from said hoist, an upper hoist adjacent said carrier rotatable with said gun as it moves in train and having a passage for receiving said unit, means for rotating said carrier from a position with said chamber aligned with said last mentioned passage to a position with said chamber aligned with said first mentioned passage, and means for selecting the direction of rotation of said carrier which will bring said carrier to said latter position in the shortest period of time.

27. A gun mount for supporting a gun for movement in train and in elevation having in combination, means for rotating said gun about a vertical axis in different directions to provide training movement, means for supplying ammunition to said gun including a lower hoist having a stationary casing with a passage for receiving a unit of ammunition, a rotatable carrier above said hoist having a chamber for receiving said unit from said passage, an upper hoist adjacent said carrier rotatable with said gun as it moves in train and having a passage for receiving said unit, means for rotating said carrier from a position with said chamber aligned with said first mentioned passage to a position with said chamber aligned with said last mentioned passage, and means for selecting the direction of rotation which will bring said carrier to said latter position in the shortest period of time whether said upper hoist is moving in either direction or is stationary.

28. A gun mount for supporting a gun having in combination, a fluid-operated motor for moving said gun to provide training movement, a pump for supplying fluid under pressure to said motor, a member movable to vary the discharge of said pump to vary the speed and direction of rotation of said motor, a lower hoist having a stationary tube for receiving a unit of ammunition, a rotatable carrier having a chamber adapted to receive said unit and movable to a position with said chamber aligned with said tube to receive said unit, a second member movable with said gun in its training movement, said carrier being mounted on said member and rotatable relatively thereto, a second fluid-operated motor for rotating said carrier, a control mechanism for said second motor comprising a differential gear assembly, means for driving said assembly rotated in synchronism with the speed of said first mentioned motor, means for driving said assembly rotated in synchronism with said second motor, a third member moved by said assembly constituting the output of said assembly, a second differential gear assembly, means for driving said second assembly in synchronism with said third member, means for operating said second assembly in synchronism with the movement of said first mentioned members, a fourth member moved by said second assembly and constituting the output member thereof, and means actuated by said fourth member for controlling the rotation of said carrier whereby compensation is had to hold said carrier stationary when said chamber is aligned with said lower hoist tube while said gun is moving in train.

29. A gun mount for supporting a gun having in combination, means for rotating said gun about a vertical axis to provide training movement, a lower hoist having a stationary passage for receiving a unit of ammunition, a rotatable carrier above said hoist having a chamber for receiving said unit, an upper hoist adjacent said carrier rotatable with said gun about said axis and having a passage for receiving said unit, a fluid-operated motor for rotating said carrier to bring said chamber into alignment with either of said passages respectively, a valve casing, a valve movable in said casing, conduits connecting said valve casing and said motor, means for supplying fluid under pressure to said valve casing for moving said valve to different positions, said valve in one position causing said fluid to rotate said motor in one direction and in another position causing said fluid to rotate said motor in the opposite direction, a second valve casing, connections from said second valve casing to said first mentioned valve casing, a second valve in said second valve casing, and means for supplying fluid under pressure to said second valve casing for moving said second valve to positions for controlling said first mentioned valve and moving the same to positions

for rotating said motor and carrier in opposite directions respectively and movable to a third position for bypassing fluid from said motor so that said motor and carrier are not rotated.

30. A gun mount for rotatively supporting a gun, having in combination, means for supplying ammunition to said gun including a fluid-operated motor for rotating said gun to provide training movement, a pump for supplying fluid to said motor having stroke-changing means, a shaft driven by said motor, a lower hoist having a tube for receiving a unit of ammunition, a carrier above said hoist having a chamber for receiving said unit of ammunition, said carrier being rotatable to a position with said tube and chamber in alignment, a second fluid-operated motor for rotating said carrier to bring said chamber into alignment with said tube, a second shaft driven by said second motor, a differential gear assembly to which said shafts are connected, a member driven by said differential constituting the result or output of said differential, a second member driven in synchronism with said member, a second differential to which said second member is connected, a third member movable in synchronism with said stroke-changing means connected to said second differential, and a third member driven by said second differential representing the result or output of the same, a cam carried by said third member, a switch operated by said cam, hydraulic means for controlling said second motor and means actuated by said switch for controlling said hydraulic means.

31. The structure set forth in claim 30, a fourth member driven in synchronism with said second shaft, a valve for controlling said hydraulic means, and means actuated by said fourth member for controlling said valve when said carrier is within 45 degrees of said alignment for controlling and decelerating said carrier.

32. A gun mount for supporting a gun having in combination, a fluid-operated motor for rotating said gun to provide training movement, a pump for supplying fluid to said motor having a stroke-changing means, a shaft driven by said motor, a lower hoist having a tube for receiving a unit of ammunition, a carrier adjacent said hoist having a chamber for receiving a unit of ammunition, a second fluid-operated motor for rotating said carrier to bring said chamber into alignment with said tube, a member driven in synchronism with said second motor, a differential gear assembly driven by said member and by said first mentioned motor, said assembly also being moved by said stroke-changing means, a second member driven by said assembly and constituting the result or output thereof, a cam movable by said second member and representing the position of said carrier relative to said hoist, and means operated by said cam for determining the direction of rotation which will bring carrier into alignment in the shortest period of time.

33. A gun mount for supporting a gun having in combination, a fluid-operated motor for rotating said gun to provide training movement, a pump for supplying fluid to said motor having a stroke-changing means, a shaft driven by said motor, means for supplying ammunition to said gun including an upper hoist having a tube for receiving a unit of ammunition, a rotatable carrier adjacent said hoist having a chamber for receiving a unit of ammunition, a second fluid operated motor for rotating said carrier to bring said chamber into alignment with said tube, a valve chamber adapted to receive fluid under pressure, passages connecting said valve chamber and motor, a valve in said valve chamber movable by said fluid, a source of fluid under pressure connected to said valve chamber for moving said valve to control the speed and direction of movement of said second motor and carrier, means for controlling said valve when said carrier is farther than 45 degrees from such alignment including a differential gearing, a shaft driven from said first mentioned motor connected to said assembly, a second shaft driven from said second motor connected to said assembly, a member driven by said differential gearing representing the result or output thereof, a second member driven in synchronism with said member, a second differential gear assembly to which said second member is connected, a third member movable in synchronism with said stroke-changing means connected to said second assembly, a fourth member driven by said second assembly and representing the result or output thereof, a cam moved by said fourth member, a switch operated by said cam, and means actuated by said switch for controlling said valve.

34. The structure set forth in claim 33, said cam operating said switch when said carrier is within 45 degrees of such alignment to render said third mentioned means inoperative, and means for controlling the rotation of said carrier when within 45 degrees of said alignment comprising a mechanism driven by and in synchronism with said second shaft for moving said valve.

35. A gun mount for supporting a gun, means for rotating said gun to provide training movement, an upper hoist movable with said gun as its moves in train and having a passage for receiving a unit of ammunition, a carrier adjacent said hoist having a chamber for receiving a unit of ammunition, a second means for rotating said carrier in opposite directions to bring said chamber into alignment with said passage in the shortest period of time, a third means for controlling the rotation of said carrier when it is more than 45 degrees from said alignment, and a fourth means for controlling the rotation of said carrier when it is within 45 degrees of such alignment.

36. A gun mount for supporting a gun having in combination, an upper hoist having a passage for receiving a unit of ammunition, a rotatable carrier having a chamber for receiving a unit of ammunition, a lower hoist having a passage for receiving a unit of ammunition, means for rotating said carrier to bring said chamber into alignment with said passages in said upper and lower hoists respectively so that said unit can be transferred to said upper hoist or carrier respectively, a latch for latching said carrier to said upper hoist when said unit is to be transferred from said carrier to said upper hoist, a latch for latching said carrier to said lower hoist when said unit is to be transferred from said lower hoist to said carrier, and control means actuated by said latch when moved to unlatch said carrier from one of said hoists for causing said first mentioned means to move said carrier to said other hoist.

37. The structure set forth in claim 36, said control means including a fluid control valve, mechanism for moving said valve including a solenoid and a switch for actuating said solenoid operated by said latch whereby the operation of said switch energizes said solenoid.

38. The structure set forth in claim 36, and means for decelerating said carrier as it comes into latching position with said hoists respectively.

39. A gun mount for supporting a gun having in combination, a lower hoist having a stationary passage for receiving a unit of ammunition, a rotatable carrier above said hoist having a chamber for receiving a unit of ammunition, means for rotating and controlling said carrier to bring said chamber into alignment with said passage so that said unit can be transferred to said carrier, said means including a differential gearing, a second means for moving said gun to provide training movement, a third means for varying the speed and direction of said training movement, a fourth means operated by said third means for varying the operation of said differential gearing to compensate for the training movement of said gun relatively to said carrier to hold said carrier in position with said passage and chamber in alignment when said gun is in training movement.

40. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun including a rotatable carrier having a pair of spaced chambers therein for respectively receiving units of ammunition, means for moving units of ammunition into

said chambers, a member in each chamber arranged to be engaged and moved by one of said units, switches respectively operated by said member for indicating that a unit is present in said chamber, resilient means for moving said member when there is no unit of ammunition in said chamber for actuating said switch and indicating that there is no unit of ammunition in said chamber, and means for operating one of said switches to give a false indication in case the chamber related to said switch was rendered inoperative.

41. A gun mount for supporting a gun, having in combination, means for moving said gun to provide training movement, said mount having a portion rotatable with said gun as it moves in train, a lower hoist having a tube for receiving a unit of ammunition, a rotatable carrier above said hoist having a chamber for receiving a unit of ammunition, an upper hoist adjacent said carrier movable with said mount portion and gun in the training movement of the gun and having a tube for receiving a unit of ammunition, a fluid-operaed motor for rotating said carrier to positions with said chamber aligned with said tubes respectively, a valve casing, a valve movable in said casing, conduits extending from said valve casing to said motor, means for supplying fluid under pressure to said valve casing for moving said valve, said valve in one position causing said fluid to rotate said motor and carrier in one direction and in another position causing said fluid to rotate said motor and carrier in the opposite direction.

42. The structure set forth in claim **41**, said valve casing and valve having means for controlling the amount of fluid delivered to said motor for controlling the speed of said motor and carrier.

43. A gun mount for supporting a gun having a portion rotatable with said gun to provide training movement, a lower hoist having a tube for receiving a unit of ammunition, a rotatable carrier above said hoist having a chamber for receiving a unit of ammunition, an upper hoist above said carrier rotatable with said mount portion and having a tube for receiving a unit of ammunition, a fluid-operated motor for rotating said carrier to positions with said chamber aligned with said tubes respectively, a valve casing, a valve movable in said casing for controlling the direction and speed of rotation of said motor and carrier, a second valve casing, a second valve in said latter casing, the position of said second valve determining whether said carrier will move to a position with said chamber aligned with said lower hoist tube or with said chamber aligned with said upper hoist tube, means for suplying fluid under pressure to said valve casings and motor, an electrically operated means for positioning said second valve.

44. A gun mount for supporting a gun, having in combination, means for rotating said gun to provide training movement, a lower hoist having a stationary passage for receiving a unit of ammunition, a rotatable carrier above said hoist having a chamber for receiving said unit of ammunition, a member which moves with the gun as it moves in train on which said carrier is rotatably mounted, said gun rotating means including a hydraulic motor, a second hydraulic motor for rotating said carrier, a pump having a stroke-varying means for supplying fluid to said first mentioned motor, a valve for controlling fluid under pressure for operating said second motor, and means for moving said valve including a differential gearing driven from said second motor and controlled by said stroke-varying means.

45. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun including an upper hoist having a tube for receiving a unit of ammunition, a rotatable carrier adjacent said hoist having a chamber for receiving said unit, a lower hoist having a hoist tube adapted to receive the unit of ammunition, means for rotating said carrier to bring said chamber into lateral alignment with said lower hoist to tube, said hoist including means for moving said unit upwardly in said tube and into said chamber, means for actuating said carrier rotating means to rotate said carrier to bring said chamber into alignment with said upper hoist tube, and means for transferring said unit sidewise from said chamber to said tube.

46. The structure set forth in claim **45**, said last mentioned means comprising a plurality of swinging members having portions engaging said unit, and means for swinging said members engaged with said unit whereby said unit is swung to said tube.

47. The structure set forth in claim **46**, and a swinging member in said upper hoist co-operating with said swinging members adapted to engage and move said unit into place in said tube.

48. The structure set forth in claim **47**, and means in said tube against which said unit is held by said last mentioned swinging member.

49. The structure set forth in claim **46**, said means comprising members with arcuate surfaces respectively engaging opposite sides of said unit in said chamber, and means for simultaneously swinging said members to move said unit toward and into said tube, said tube having a member with an arcuate surface engaging said unit for positioning the same in said tube.

50. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun including a cradle swingable from a receiving position to a delivery position and comprising an elongated casing of general cylindrical form having a chamber therein for receiving a unit of ammunition when in said receiving position, said casing having a section thereof swingable laterally and outwardly about an axis extending longitudinally of said casing, a plurality of levers spaced longitudinally of said casing and pivoted at one side of said casing to swing about an axis extending longitudinally of said casing, said levers being formed at one end to embrace said unit, means for swinging said section when said cradle is in said delivery position, and means for swinging said levers for swinging said unit out of said casing when said section is swung outwardly.

51. The structure set forth in claim **50**, said casing having spaced openings extending transversely thereof in which said levers are disposed and movable.

52. A gun mount for supporting a gun having in combination, means for supplying ammunition to said gun, including an upper hoist having a passage for receiving a unit of ammunition and comprising means for moving said unit in said passage, a cradle swingable from a receiving position in alignment with said upper hoist to a delivery position, means for swinging said cradle between the two positions, said cradle comprising an elongated casing having a chamber into which said unit is moved by said means when the cradle is in receiving position, said casing having upper and lower portions hinged to swing outwardly about axes respectively extending lengthwise of said casing, and means for swinging said portions when said cradle is in delivery position, whereby said unit can be moved sidewise out of said chamber.

53. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including a cradle for receiving a round of ammunition, an arm carrying said cradle at one end and swingable about an axis at its other end, a second arm for swinging said arm about said first mentioned axis to move said cradle from a receiving position to a delivering position, a cam disposed about said first mentioned axis, a lever having a cam roller engaging said cam, and means operated by said lever for decelerating said cradle as it nears delivery position.

54. A gun mount for supporting a gun for movement in train and elevation, trunnions about the axis of which said gun swings to provide elevating movement, means for supplying ammunition to said gun including a cradle having a chamber therein for receiving a round of am-

munition, an arm carrying said cradle at one end and swingable about said axis at its other end, a second arm pivoted at one end to said arm and forming a cylinder, the same being pivoted about a fixed axis at its other end, a member having a piston at one end movable in said cylinder and pivoted at its other end to said first mentioned arm, hydraulic means for moving said member for swinging said cradle about said first mentioned axis from a receiving position to a delivery position.

55. A gun mount for supporting a gun for movement in train and elevation, having in combination, trunnions about the axis of which said gun moves to provide elevating movement, means for supplying ammunition to said gun including a cradle having a chamber therein for receiving a unit of ammunition, an arm carrying said cradle swingable about said axis, a second arm pivoted at one end about a fixed axis and connected by a pivot to said arm at its other end, a cam disposed adjacent one of said trunnions, a lever fulcrumed on said second arm and spring biased toward engagement with said cam, a roller carried by said lever engaging said cam, a shaft journaled on said second arm, oscillated by said lever, a valve moved by said shaft, and means controlled by said valve for decelerating the movement of said piston and member for decelerating said cradle as it nears delivery position.

56. The structure set forth in claim 55, a third arm connected to said shaft, a rod connecting said third arm and said lever, and a fourth arm connected to said shaft and to said valve.

57. The structure set forth in claim 56, said first mentioned rod passing through said pivot.

58. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including an upper hoist having a tube for receiving a round of ammunition and comprising means for moving said round in said tube, a cradle having a chamber therein for receiving a round of ammunition, said cradle being movable to a receiving position with said chamber aligned with said tube for having a round of ammunition moved thereinto by said means, and means for engaging said round and moving it farther into said chamber if said round is of shorter than a certain length.

59. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including an upper hoist having a tube for receiving a round of ammunition and comprising means for moving said round in said tube, a cradle having a chamber therein for receiving a round of ammunition, said cradle being movable to a receiving position with said chamber aligned with said tube for having a round of ammunition moved thereinto by said means, a member engaged and moved by said round as it moves into said chamber, a stop engageable by said member positioning said round if said round is of a certain length, a second member for engaging the end of said round, and means for moving said second member and said first mentioned member to engage said stop if said round is shorter than said certain length.

60. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including an upper hoist having a tube for receiving a round of ammunition and comprising means for moving said round in said tube, a cradle having a chamber therein for receiving a round of ammunition, said cradle being movable to a receiving position with said chamber aligned with said tube for having a round of ammunition moved thereinto by said means, a member engaged and moved by said round as it moves into said chamber, a stop engageable by said member positioning said round if said round is of a certain length, a second member for engaging the end of said round, a valve rod connected to said second member, a piston connected to said rod, a piston chamber in which said piston is movable, and means for supplying liquid under pressure to said chamber for moving said piston and second mentioned member to move said round and move said member against said stop if said round is less than said certain length.

61. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including an upper hoist having a tube for receiving a round of ammunition and comprising means for moving said round in said tube, a cradle having a chamber therein for receiving a round of ammunition, said cradle being movable to a receiving position with said chamber aligned with said tube for having a round of ammunition moved thereinto by said means, a member adapted to engage the rear end of said round, a piston connected to said member, a chamber in which said piston is movable, means for supplying liquid under pressure for moving said piston, a valve for controlling said last mentioned means, a lever connected to said valve, and means for moving said lever for moving said valve for in turn moving said member to move said round while in said cradle.

62. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including a cradle comprising an elongated casing having a chamber therein for receiving a round of ammunition, said casing having a pivoted portion forming a shutter, means for swinging said shutter to open and closed positions, and an electrical switch actuated by said means when said shutter is moved to closed position, said switch indicating that said shutter is closed.

63. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including a cradle comprising an elongated casing having a chamber therein for receiving a round of ammunition, said casing having a portion swingable outwardly about an axis extending longitudinally of said casing for providing a discharge opening for said round, a piston casing moving with said cradle, a piston movable in said piston casing, means movable by said piston for swinging said portion, and means for supplying fluid under pressure to said piston casing for moving said piston and an electrical switch actuated by said piston when said portion is moved to closed position, said switch indicating that said portion is in retracted position and said discharge opening is closed.

64. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including a transfer tray comprising an elongated casing of general cylindrical form, said casing having a shutter at one side thereof movable to open and closed positions, means for swinging said tray to a receiving position at one side of said gun and adjacent the rear thereof, means for opening said shutter, means for delivering a unit of ammunition to said tray, means for closing said shutter, and means for moving said tray to a discharge position in alignment with the bore of said gun.

65. The structure set forth in claim 64, and means for clamping said unit in said tray during said movement of said tray to discharge position and for releasing said clamping means when said tray reaches said discharge position.

66. The structure set forth in claim 65, said clamping means comprising a swinging holding means for said round, means for swinging said holding means to inoperative position when said round is received in said tray and for moving the same to operative position when said round is in position in said tray.

67. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including a transfer tray adapted to receive a unit of ammunition and disposed at one side of said gun adjacent the rear end thereof, said tray comprising an elongated casing having an opening in one side, said casing having a fixed portion and a portion closing said opening but swingable outwardly about an axis extending longitudinally of said casing to open position, means for swinging said last mentioned portion to open position to re-

ceive said unit and to closed position when said unit is in said tray, and means for moving said unit sidewise into said tray through said opening when said last mentioned portion is in open position.

68. A gun mount for supporting a gun, having in combination, an ammunition handling and disposal system including means for supplying ammunition to said gun, said means comprising a pair of transfer trays disposed in receiving positions at each side of said gun respectively and adjacent the rear end thereof, means for alternately swinging said trays from said receiving positions to ramming positions respectively with said trays in alignment with the bore of said gun, an empty case tray movable to a receiving position substantially in alignment with the bore of said gun and contemporaneously with movement of either of said transfer trays to a discharge position spaced from said bore, and means for swinging said empty case tray to said receiving position between each movement of one of said transfer trays to ramming positions.

69. The structure set forth in claim **68**, and means for stopping the movement of a transfer tray to said delivery position if said empty case tray does not move to discharge position.

70. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including a transfer tray movable to a receiving position at one side of said gun and adjacent the rear end thereof, means for moving a unit of ammunition into said tray, a member disposed in said tray adapted to be moved by said unit as it is received in said tray, an electrical switch actuated by said member for indicating that said unit is now in said tray, said tray comprising an elongated casing of substantially cylindrical form, said casing having an outwardly swingable section forming a shutter, means for swinging said shutter to open closed position, and a switch actuated by said means for indicating that the shutter is in closed position, means for clamping said unit in said tray, and an electrical switch actuated by said clamping means as it moves to clamping position for indicating that a round is now clamped in said tray.

71. A gun mount for supporting a gun, having in combination, means for supplying ammunition to said gun, including a transfer tray movable to a receiving position at one side of said gun and adjacent the rear end thereof and to a delivery position in alignment with the bore of said gun, means for moving said tray to said positions respectively, electrical switches actuated by said tray moving means for indicating when said tray is in said positions, means for moving a round of ammunition into said tray, a round-clamping member movable to clamping and releasing positions, hydraulically actuating means for moving said clamping member, a chamber, a piston movable in said chamber for controlling said last mentioned means, electrically operated means for moving said piston to cause said first mentioned means to move said member to clamp said round when the latter has been delivered to said tray, and an electrically operated means for moving said piston to cause said last mentioned means to move said clamping member to release position as said tray nears its delivery position.

72. A gun mount for supporting a gun for movement in train and elevation, having in combination, a magazine device into which rounds of ammunition are placed by an operator, a rotatable carrier above and spaced from said device, a lower hoist for moving said round from said device into said carrier, an upper hoist, means for delivering said round from said carrier to said upper hoist, a cradle to which said round is delivered by said upper hoist, a transfer tray adjacent the breech of said gun, means for moving said cradle into alignment with said tray, means for delivering said round from said cradle to said tray, means for moving said tray into alignment with the bore of said gun, and means for moving said round into said bore.

73. The structure set forth in claim **72**, said upper hoist being movable with said gun in the training movement of said gun.

74. A gun mount for supporting a gun, having in combination, a pair of magazine devices into each of which a round of ammunition is placed by an operator, a rotatable carrier above said devices having a pair of spaced chambers each adapted to receive a round of ammunition, a lower hoist having spaced means for moving rounds of ammunition from said devices respectively to said chambers of said carrier, an upper hoist having spaced passages each adapted to receive a round of ammunition, means for transferring a round of ammunition from either of said chambers in said carrier to either of said passages in said upper hoist, a pair of cradles adapted respectively to move into positions aligned with said chambers in said upper hoist, means for moving rounds of ammunition from said chambers in said upper hoist to said cradles respectively, a transfer tray at each side of said gun adjacent the rear thereof having a chamber therein for receiving a round of ammunition, means for moving said cradles into positions aligned respectively with said transfer trays, means for delivering a round of ammunition from each cradle to a transfer tray, means for alternately moving said transfer trays into a delivery position aligned with the gun bore, and means for moving a round of ammunition from a transfer tray in said latter position into said bore.

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