

Feb. 20, 1951

V. S. KRAEGER ET AL
AMMUNITION SUPPLY SYSTEM

2,542,200

Filed Feb. 14, 1947

4 Sheets-Sheet 1

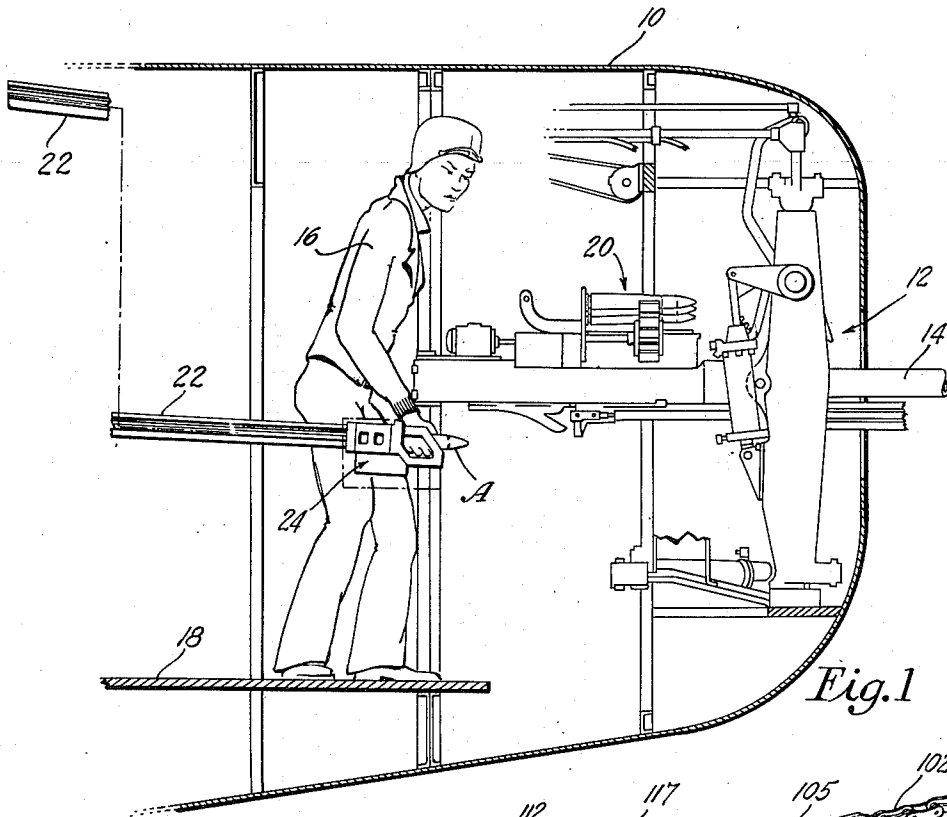


Fig. 1

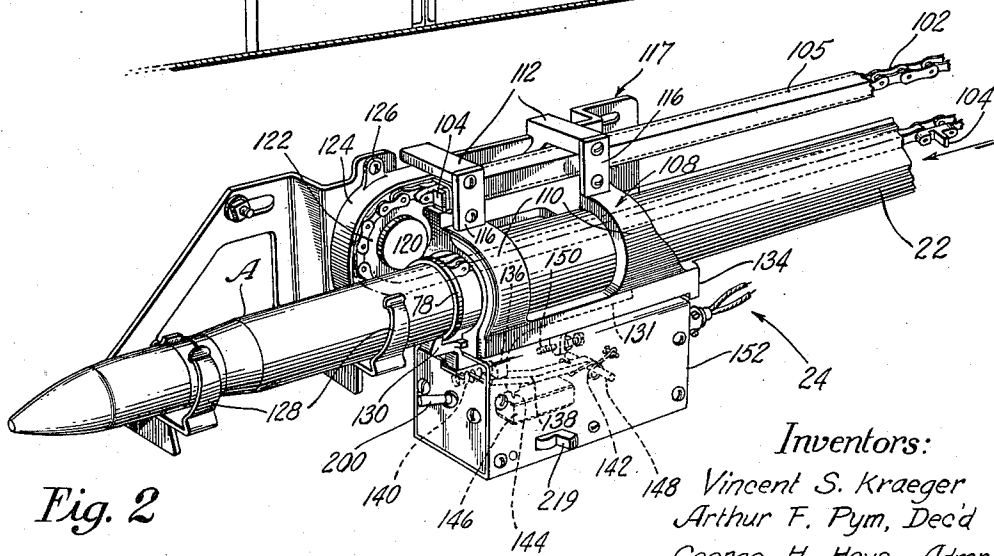


Fig. 2

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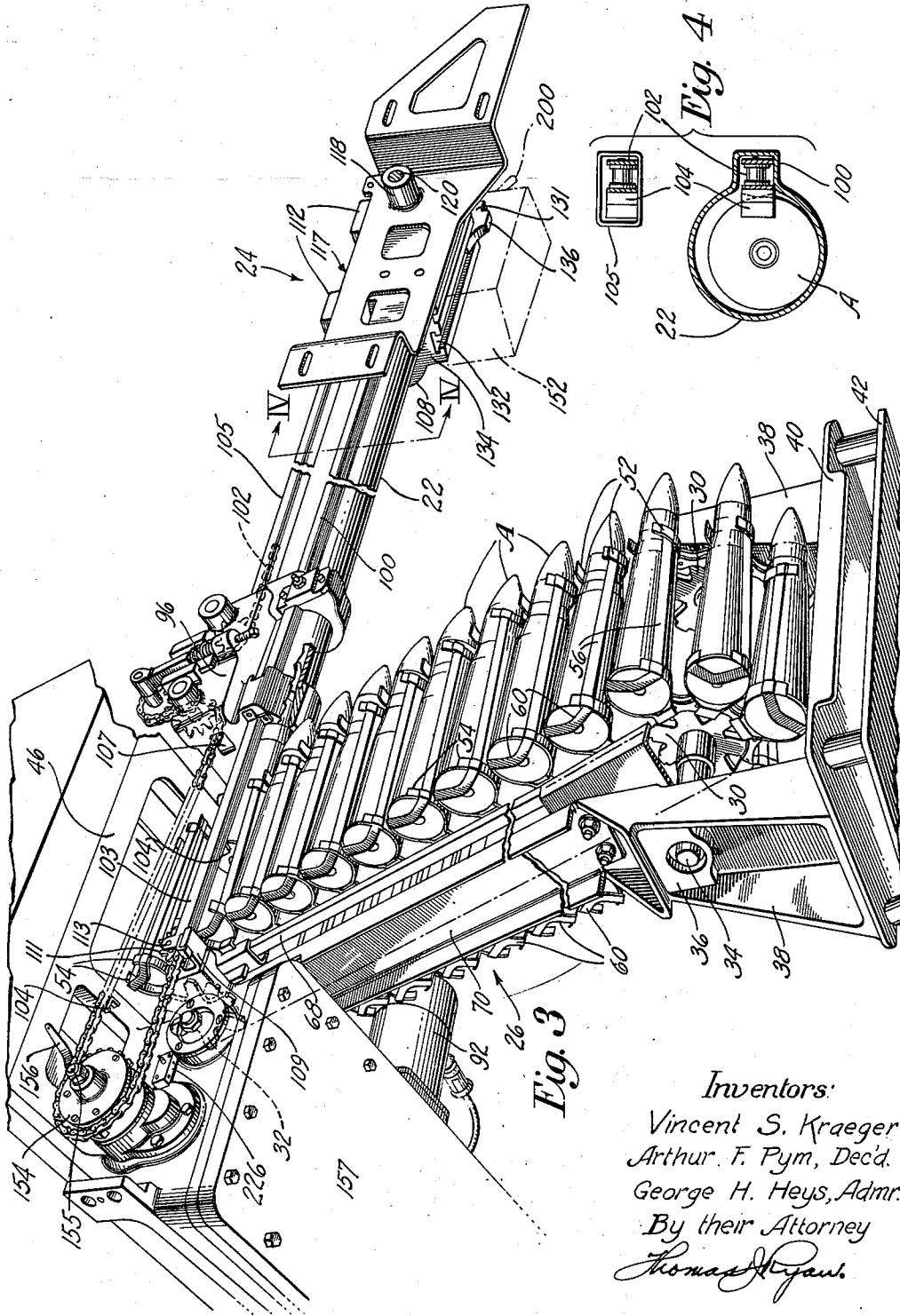


Fig. 3

Fig. 4

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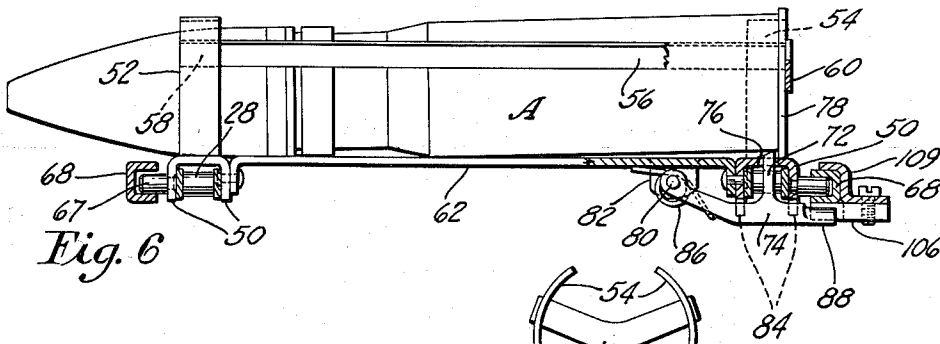


Fig. 6

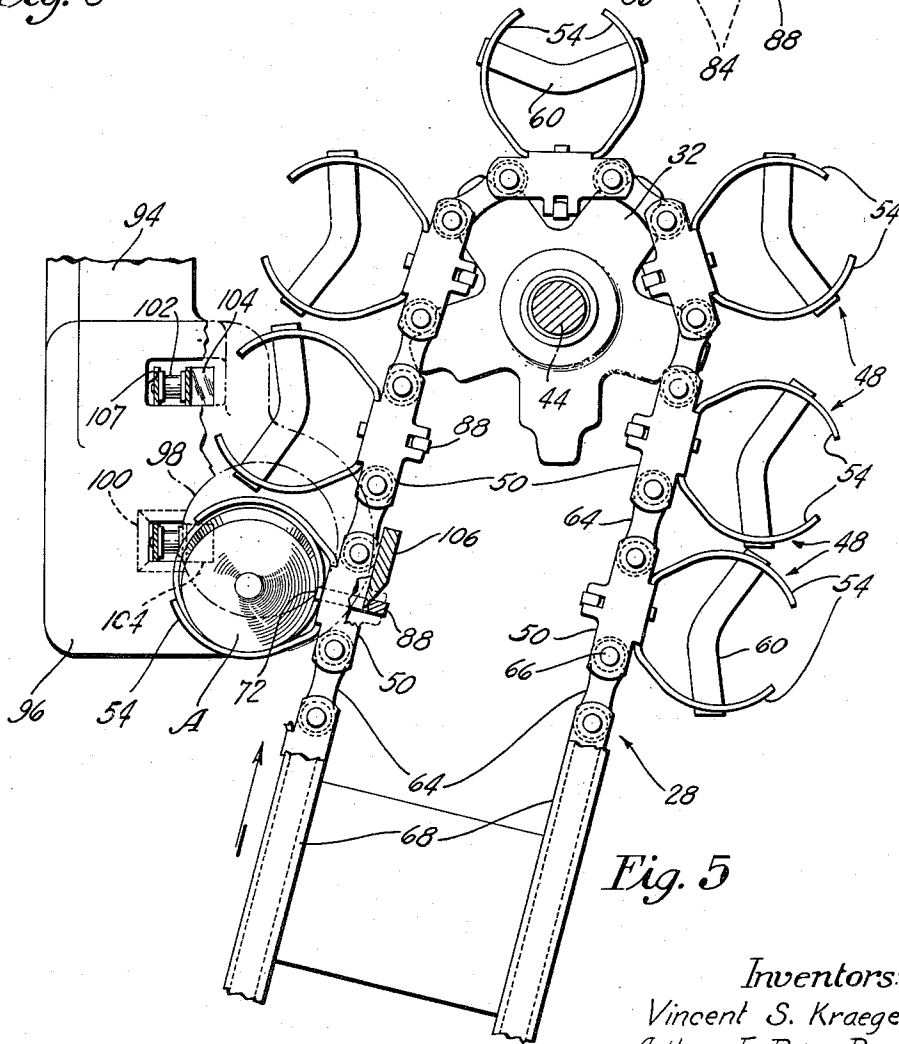


Fig. 5

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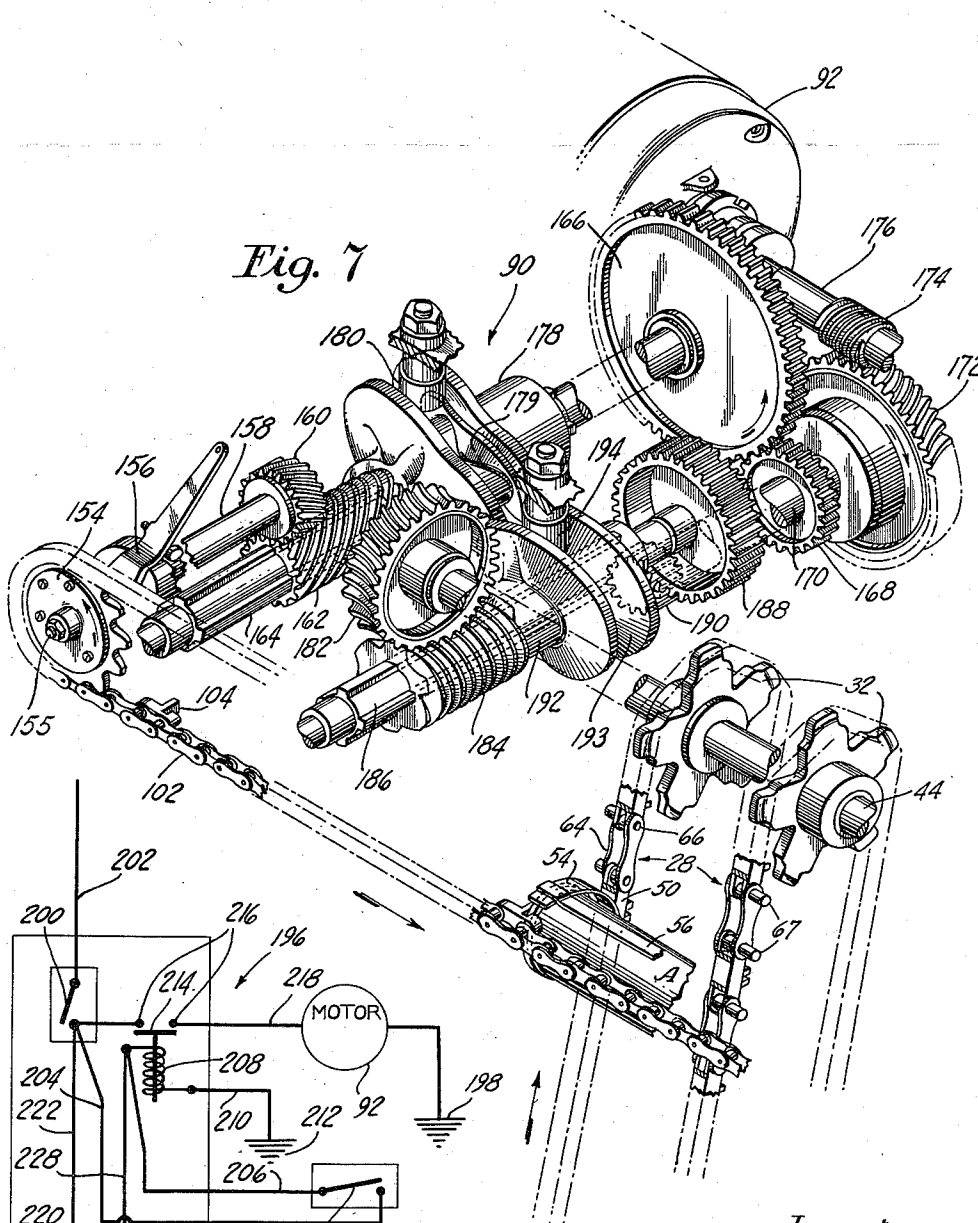
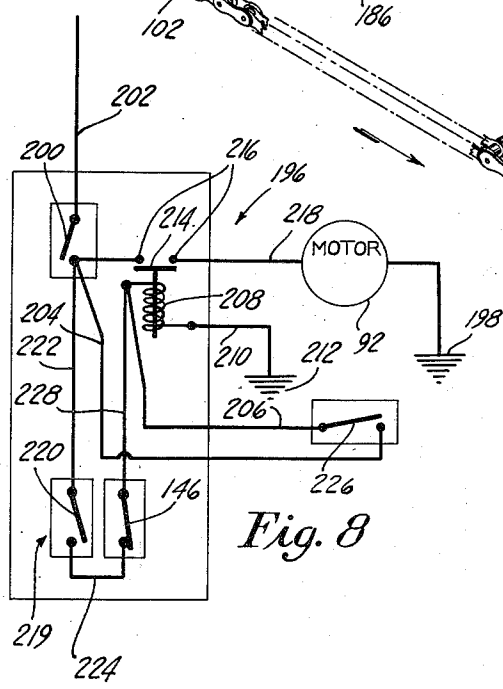


Fig. 8



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UNITED STATES PATENT OFFICE

2,542,200

AMMUNITION SUPPLY SYSTEM

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Application February 14, 1947, Serial No. 728,630

2 Claims. (Cl. 198—37)

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This invention relates to ammunition supply systems for aircraft and particularly to a system for maintaining an adequate flow of ammunition to automatic guns mounted in constricted spaces such, for example, as in the tail end of an airplane.

A 37 mm. automatic gun, for example, is capable of firing at a rate as high as 120 rounds a minute and obviously the quantity of ammunition which may be required in a short time under combat conditions will occupy more space than is available at a gun station in a turret or the tail of an airplane. It is the object of the present invention to provide for the automatic delivery, to the constricted space adjacent to the gun at such a station, of a continuous supply of ammunition at any rate at which it might be needed. With this in view the invention provides a power driven round transferer which is automatically responsive to the presence or absence of a round of ammunition at the gun station to transfer individual rounds successively from a large source of supply, such as a magazine in the mid-portion of an aircraft where there is sufficient room for ammunition storage, to a delivery position in the constricted space at a gun station, so that whenever the gunner picks up a round to insert it in a cartridge feeder upon the gun, another round immediately takes its place and, consequently, there is always a round at hand ready for use, even though there is no space available at the gun station for storage of a reserve supply. In the illustrated embodiment of the invention the ammunition magazine which constitutes a large source of supply consists of an upright endless carrier located in the mid-portion of an aircraft where there is ample room. A round transferer extends from the upper end of the magazine rearward along the ceiling of the fuselage to a delivery position in the constricted space at the gun station in the tail of the aircraft. The endless carrier and the transferer are normally both moved intermittently, each moving during periods when the other is at rest and both being stopped whenever there is a round of ammunition in the delivered position at the gun station, where the delivered round, if it is not removed by the gunner, engages and holds open a switch controlling the power supply circuit of an electric motor by which the mechanisms are operated. As soon as the gunner picks up the round to place it in the cartridge feeder on the gun the switch closes, the motor starts, and another round is delivered immediately to the gun station so that the gunner may replenish the cartridge feeder as fast as it is emptied.

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The features and details of the invention will be readily understood from the following description of one embodiment thereof when read in connection with the accompanying drawings in which,

Fig. 1 is a vertical section through the tail end of a plane showing a 37 mm. gun and mount and the positions of a gunner and the end portion of an ammunition round transferer relative thereto;

Fig. 2 is a perspective view of the end portion of the ammunition round transferer, enlarged to illustrate switch operating mechanism for controlling operation of the transferer;

Fig. 3 is a perspective view of the supply magazine midway of the plane and the rear portion of the transferer tube;

Fig. 4 is a section on the line IV—IV of Fig. 3;

Fig. 5 is an elevation near the top of the supply magazine as seen from the right side of Fig. 3 mostly in the plane of the forward one of the endless chains, showing the endless chain and clips which support the base ends of the rounds of ammunition and the bracket which supports the forward end of the transferer tube;

Fig. 6 is a side view, partly in section, illustrating the constructional features of the ammunition round clip and its attachment to the endless chain;

Fig. 7 is a perspective view of the power operated means for driving the magazine and the transferer chains; and

Fig. 8 is a diagrammatic layout of the electrical circuit for controlling the power operated means.

Referring to the drawings, Fig. 1 shows a vertical section through the tail portion 10 of an airplane in which there is mounted, on a suitable trunnioned support 12, a 37 mm. automatic gun 14 which may be operated by a gunner 16 standing on the floor 18 at the rear of the gun. The gun is provided with the usual feed magazine 20 which holds a sufficient number of rounds of ammunition for several short bursts of fire. The magazine 20 is replenished with ammunition by the gunner at intervals between bursts of fire, while the gun is cooling. Because of the rather constricted space available in the tail portion of the plane and because the gun uses a large quantity of ammunition, it is not feasible to store an adequate supply of ammunition in the vicinity of the gun. Hence, the present invention provides for transferring ammunition from a remote point, for example, in the midportion of the airplane, where there is ample space for storing ammunition, to the gunner in the constricted space, in a convenient position for him to receive it one

round at a time for insertion in the feed magazine 20. As indicated in Fig. 1, a rear end attachment 24 to an ammunition transfer tube 22 is located at a height which corresponds to the normal position of the hand of the gunner when standing with his arm dropped at his side, so that he may readily grasp a round of ammunition A delivered to the attachment 24 without having to look away from his target. The ammunition transfer tube 22 extends from the attachment 24 at the tail, or any constricted portion, of the airplane, upward along the ceiling of the plane to a supply magazine indicated generally at 26 (Fig. 3) located in the midportion of the plane. The magazine 26 consists of a pair of parallel spaced endless chains 28, inclined slightly from the vertical, mounted upon pairs of sprockets 30 and 32 (Figs. 3 and 5). The sprockets 30, 30 are fixed to a shaft 34 which is journaled in a horizontal position in bearings 36 formed integral with spaced upright posts 38 fixed at their lower ends to a base plate 40, the latter being in turn fastened to the floor 42 of the airplane in the midportion thereof. The upper pair of sprockets 32, 32 are fixed to a horizontal shaft 44 parallel to the shaft 34 (Figs. 5 and 7), this shaft being supported from the ceiling 46 of the airplane in suitable bearings, not shown herein, and being driven to impart linear movement to the chains 28 intermittently as will appear hereinafter.

Secured to the chains 28 are ammunition round carriers 48 (Fig. 5), the carriers being fixed to alternate links 50 of the chains 28 and extending transversely between the chains. Each carrier consists of rear and forward pairs of curved fingers 52 and 54 (Figs. 3 and 5), longitudinally spaced to embrace respectively the nose and base of a round of ammunition. The forward and rear fingers at each side of the carrier are joined by a strap 56 (Figs. 3 and 6) which is welded at one end to one of the rear fingers 52 at 58, extends forward to the forward fingers 54 on the same side, to which it is welded, then crosswise between the forward fingers 54, being welded to the opposite one of the forward fingers 54 and finally rearward to the opposite rear finger 52, to which it is welded. The cross-portion, designated 60, of the strap forms an abutment against which the base flange 78 of the round of ammunition A abuts and is held, as will appear hereinafter. For supporting the under side of the round of ammunition and also for maintaining the spacing between the chains 28, corresponding opposite links 50 in the chains 28 are riveted to the opposite ends of a strap 62 disposed between them. The links 50 of each chain are joined by intermediate links 64 (Fig. 5) to which they are pivoted by pins 66 and the chains are guided by channel-shaped members 68 (Figs. 3 and 6), fastened to inclined, channel-shaped, structural members 70. The structural members 70 are each bolted at one end to the upper ends of the posts 38 and at the opposite end to brackets (not shown) depending from the ceiling 46. To effect the guiding of the chains and to prevent sagging due to the weight of the ammunition, the pins 66 which join the links have laterally extending portions 67 (Figs. 6 and 7) which project into the channel-shaped members 68.

In order to hold each round of ammunition A securely in its carrier 48 so that it will not slip out, even during the most violent gyrations of the airplane, each of the links 50 of the chain 28 is provided adjacent to the base of the round of ammunition with a locking finger 72 (Figs. 5

and 6) adapted to engage the rear side of the flange 78 to lock it against the cross-portion 60. The finger 72 is formed integral with an arm 74 and projects upwardly therefrom through an opening 76 formed in the link 50. The arm 74 is pivoted on a pin 80 supported between ears 82 fixed to the under side of the strap 62. A torsion spring 86 surrounding the pin 80 and bearing at one end against the strap 62 and at its other end against the arm 74 yieldably urges the arm in a direction to cause the finger 72 to project through the opening 76 into engagement with the flange 78. The arm 74 is guided in its movement by slots 84 formed in the under side of the link 50 with which it is associated. The arm 74 is also provided with a laterally extending portion 88 which projects beyond the link 50 of the chain and provides means, which will be described, for withdrawing the finger 72 at the proper time from behind the flange 78 to release the round of ammunition.

The chains 28 are intermittently driven, as will be hereinafter described, by the sprockets 32, 32 which are connected through gearing 90 to an electric motor 92 (Figs. 3 and 7). The movement of the chains 28 is such as to bring one round at a time of ammunition in its carrier 48 opposite the forward end of the transfer tube 22, shown in phantom at 98 (Fig. 5), which is supported at its forward end by a casting 96 formed at the lower end of a depending bracket 94 secured to the ceiling of the airplane. The transfer tube 22 is a hollow substantially cylindrical member (Fig. 4) of sufficient inside diameter to accommodate the ammunition and is supported from the ceiling of the airplane at spaced points throughout its length, the supports being of a conventional type and not illustrated herein. The forward end of the transfer tube is supported by the casting 96 in alignment with the normal stopping position of one of the ammunition carriers 48 on the chains 28 near the top thereof so that if a round of ammunition is pushed lengthwise from its carrier, it will enter the forward end of the transfer tube 22. To accomplish this, there is provided an endless chain 102 which is driven by a sprocket 104 (Fig. 3) and passes around an idle sprocket 122 at the rear end of the transfer tube. The chain 102 is so disposed that one of its runs lies close to the carrier opposite the forward end of the tube 22. That portion of the chain which travels lengthwise of the carrier is guided and supported in its movement by a channel member 103 fixed at one end to the casting 96 and at its other end to an outstanding bracket 109 formed integral with a gear housing 157. An idle sprocket 111 mounted on a pin between ears 113 formed at one end of the channel member 103 overlies the chain, directing it into the channel member 103 and holding it therein. At spaced intervals along the chain 102, specifically at distances equal to the length of a round of ammunition, there are fixed fingers 104 each of which, as the chain moves rearward from the sprocket 104 toward the transfer tube, will engage the base of a round of ammunition in the carrier and move it from the carrier into the transfer tube. A substantially rectangular housing 100 through which the chain passes and in which it is supported extends along one side of the transfer tube 22 (Fig. 4), the housing overlying a longitudinal slot formed lengthwise of the transfer tube 22, which permits the fingers 104 carried by the chain to project through into the transfer tube and to move the

entire length of the tube, to push a round of ammunition from one end to the other. The other run of the chain is supported by a housing 105 (Figs. 3 and 4) which is secured parallel to the transfer tube 22 between the casting 96 and a casting at the rear end of the transfer tube to be hereinafter described. Openings 107 are formed in the casting 96 through which the runs of the chain 102 may pass forward from the forward ends of the housings 100 and 105 to the sprocket 154.

In order to release a round of ammunition from its carrier 48, there is provided a stationary wedge-shaped member 106 (Figs. 5 and 6) secured by a bracket 109 (Fig. 6), to which it is bolted, to the channel-shaped guide 68 adjacent to the base of the ammunition in a position to be engaged by the inside of the end portion 88 of the arm 74 (Fig. 6) to withdraw the finger 72 simultaneously with the movement of the carrier into a position opposite the forward end of the transfer tube 22.

Referring now to the attachment 24 at the rear end of the transfer tube 22, there is shown in Fig. 2 a casting 108 having spaced circular arms 110 adapted to embrace the rear end portion of the tube 22. This casting also has spaced overhanging arms 112 to which the rear end of the chain housing 105 is fastened, the latter being secured between the casting and the overhanging arms 112 by plates 116. Secured to one side of the casting is a plate 117 which is adapted to be fastened to the wall of the airplane or some other supporting member fixed in the tail portion of the plane to hold the casting at the proper height-wise position as heretofore mentioned. The plate 117 is provided with a bearing sleeve 118 (Fig. 3) in which there is journaled a stub shaft 120 to which there is fixed a sprocket 122 (Fig. 2) over which the chain 102 passes. A chain guard 124 extends around the chain and the sprocket and is secured to the plate 117 at 126. There are also secured to the plate 117, in alinement with the rear end portion of the transfer tube 22, pairs of spaced concave resilient fingers 128 adapted to receive and embrace the nose and base of a round of ammunition A as it is delivered from the end of the tube.

In order to prevent the feeding of further ammunition to the fingers 128 when they already contain a round, means is provided for automatically stopping the driving motor if the gunner does not remove the round from the fingers. This means comprises a hook-shaped member 130 (Fig. 2) which projects upward into the path of the round adjacent to the end of the transfer tube from one end of a slide 131 reciprocable in ways 132 (Fig. 3) cut in the base 134 of the casting 108. The slide 131 is provided with a downwardly projecting finger 136 which is adapted to engage, when the slide has been moved rearward by a round engaging the hook 130, the upwardly inclined end of an arm 138 pivoted on a pin 148 and to push the arm down into engagement with a switch button 144 of a switch 146, to hold an operating circuit (to be described hereafter) of the motor 92 open so that the driving mechanism 90 will be at rest. The arm 138 is yieldably held out of contact with the switch button 144 by a spring 142 and will only be depressed by movement of the slide 131 to a rearward position, as indicated in the drawings. The slide 131 is normally urged forward by a spring 140 and will take up a position against an adjustable stop 150 when there is no ammunition present in the fingers 128.

When such a condition exists the aforementioned circuit is automatically closed to start the motor and, hence, to cause the chain 102 to deliver another round of ammunition from the end of the transfer tube into the fingers in a position to be picked up by the gunner.

Returning now to the magazine end of the apparatus, the means for rotating the sprocket 154 to drive the chain 102 and also the means for rotating the sprockets 32 to drive the chains 28 will now be described.

The sprocket 154 (Fig. 7) is fixed to a shaft 155 journaled in one wall of the gear box 157 (Fig. 3) and is connected by a clutch 156 to one end of a horizontal shaft 158 also journaled in suitable bearings in the gear box as are all the other shafts hereinafter to be mentioned. The shaft 158 has fixed to it at its opposite end a helical gear 160. The gear 160 meshes with a helical gear 162 splined for longitudinal movement on a shaft 164 to which is fixed a gear 166 meshing with a gear 168 fixed to a parallel shaft 170. A worm gear 172 fixed to the shaft 170 meshes with a worm 174 fixed to the motor shaft 176. When the motor 92 is operating, power will be transmitted to the sprocket 154 to drive the chain 102 through the described gear train. It is necessary that the chain 102 shall operate intermittently in timed relation to similar intermittent movement of the chains 28 of the magazine, in such a way that the chain 102 will be stationary while the chains 28 are moving a round of ammunition into alinement with the forward end of the transfer tube 22 and thereafter the chain 102 will move to transfer the round into the tube while the chains 28 are stationary. To this end there is fixed to one end of the gear 162 (Fig. 7) a hub 178 which is slidable axially with the gear 162 on the shaft 164. The hub has a cam groove 179 in its peripheral surface adapted to embrace a fixed pin 180 so that as the hub rotates with the gear 162 the groove will, because of its design, either impart axial movement to the gear 162 in such a direction and at such a rate that rotational movement will be transmitted from the motor 92 to the sprocket 154, thereby imparting linear movement to the chain 102 through a distance sufficient to move one round of ammunition from its carrier on the chains 28 into the transfer tube 22, or impart longitudinal movement to the gear 162 in the opposite direction at such a rate with respect to the gear 160 that no rotational movement of the latter occurs and hence no rotation of the sprocket 154 takes place. While this latter condition exists the chain 102 remains stationary while the chains 28 are moving another round of ammunition into position to be transferred to the tube 22.

The chains 28 are moved intermittently in a manner similar to that in which the chain 102 is moved, so that the chains 28 will advance a distance equal to the distance between the ammunition carriers, to move one round of ammunition at a time into alinement with the transfer tube 22 and then to remain at rest until the chain 102 removes the round from its carrier and pushes it into the transfer tube. To this end there is fixed to the shaft 44 a gear 182 which meshes with a worm 184 splined for longitudinal movement on a shaft 186. Fixed to one end of the shaft 186 is a gear 188 which in turn meshes with a gear 190 fixed to the shaft 170. To provide the necessary intermittent motion there is fixed to the worm 184 a hub 192, the peripheral surface of which has a cam groove 193

therein embracing a fixed pin 194. This mechanism operates in exactly the same way as the mechanism for driving the chain 102, and, hence, the description of its operation need not be repeated herein. The design of the cam groove is somewhat different from that of the groove 179 because of the fact that the chains 28 move a shorter distance than does the chain 102.

The motor 92 and the power transmitting mechanism 99, which includes the gearing described above, for operating the chains 28 and 102 are controlled by a system of switches illustrated in a circuit shown diagrammatically at 196 in Fig. 8.

As shown therein the motor 92 is grounded at 198. A source of electrical power indicated at 202 may be connected to the circuit 196 by a manually operated main switch 200 (Figs. 2 and 8). Initially, when the transfer tube contains no ammunition, the switch 146 is in a closed position by reason of the absence of a round of ammunition from the fingers 128 as heretofore explained, this switch, as will be seen by reference to the circuit diagram, being in series with a loading switch 220 by way of a conductor 224 and with the main switch 200 by way of a conductor 222. Hence by closing the loading switch 220 (Figs. 2 and 8) current may pass from the conductor 202 through the switch 200, the conductor 222, switch 220, conductor 224 and switch 146 to a conductor 228 which is connected to a solenoid 208. The solenoid is grounded at 212 by a conductor 210 connected to the solenoid coil and has a plunger 214 arranged to bridge, when actuated by excitation of the coil, spaced terminals 216 in a conductor 218 leading from the switch 200 to the motor 92. Thus the motor will start and the magazine chains 28, and the transfer chain 102, will be operated as heretofore described. As soon as the first round of ammunition reaches the rear end of the transfer tube 22 and is delivered into the fingers 128, the switch 146 will be opened, interrupting the current to the solenoid 208, with the result that the plunger 214 will be retracted, the current to the motor will be interrupted and the motor will stop. Hence movement of the magazine loading chains 28 and the transfer chain 102 will cease. At any time when the carriers on the magazine chains 28 may not be filled with ammunition and it is desired to complete the filling thereof without operating the transfer chain 102, the clutch 156 may be disengaged to disconnect the sprocket 154 from the shaft 158. Disengagement of the clutch operates by contact of its handle with a normally open switch 226 to close the switch, permitting current to pass from the switch 200 through a conductor 204, the switch 226 and a conductor 206 to the solenoid coil 208, closing the gap between the terminals 216 in the conductor 218 and starting the motor 92. The motor will now operate the loading chains 28 without operating the transfer chain, so that the magazine may be completely filled. As soon as it is filled the clutch is disengaged, permitting the switch 226 to open and stop the motor, whereupon the apparatus is in readiness for use.

From the description of the apparatus outlined above, it is evident that it provides convenient means for supplying a large number of rounds of ammunition to a constricted portion of a plane where it is impossible to store sufficient ammuni-

tion to keep a rapid firing gun supplied at all times.

In order to prepare the apparatus for operation, the main switch 200 (Fig. 8) is first closed and then if the apparatus is entirely empty of ammunition, the loading switch 220 is closed, whereupon the magazine chains 28 will begin their intermittent movement as will also the transfer chain 102. The loader will then during periods of rest of the chains 28 place ammunition in the ammunition carriers 48. As the chains 28 move a round of ammunition into position in alignment with the transfer tube 22, the transfer chain 102 will transfer the ammunition, a round at a time, into the transfer tube 22 until the transfer tube is filled, whereupon the operation of the device will be interrupted by the first round of ammunition reaching the terminal portion of the transfer tube and entering the fingers 128 so as to open the switch 146. At this time the carriers 48 will not necessarily all be filled with ammunition. Hence, in order that the magazine 28 may be completely filled up, the loader will then disengage the clutch 156 so that the transfer chain 102 will no longer move which simultaneously closes the switch 226 and, keeping the switch 226 closed, will continue to insert rounds of ammunition in the ammunition carriers 48 as the chains 28 continue their intermittent movement. When the carriers on these magazine chains have been filled with ammunition, the operator will reengage the clutch, whereupon the mechanism will come to a stop and will remain thus in readiness for use until a round of ammunition is removed from the fingers 128. At this time the switch 200 may also be opened so that there will be no chance that the mechanism will be accidentally started by unauthorized removal of a round of ammunition from the fingers 128. When the gunner is ready for firing, he will close the switches 200 and 220 so that the mechanism will be in readiness to operate automatically upon removal of a round of ammunition from the fingers 128.

As soon as the gunner removes the round of ammunition at the rear end of the transfer tube from the fingers 128, the switch 146 is automatically closed, the motor 92 is started, the transfer chain 102 moves lengthwise of the transfer tube a distance sufficient to move the round of ammunition in the carrier opposite the forward end of the transfer tube into the tube and simultaneously moves the round of ammunition in the rear end of the tube into the fingers 128 in readiness to be grasped by the gunner. Then the chain 102 comes to a stop and the magazine chains 28 move upward a distance sufficient to move the next round of ammunition into alignment with the forward end of the transfer tube and come to a stop. The chain 102 now starts and, if the gunner has not removed the round previously deposited in the fingers 128, the rim of that round, engaging the hook 130, will move the slide 131 rearward, causing the switch 146 to be opened to stop the motor, and the entire mechanism will come to a stop and remain at rest. However, if the gunner has removed that round of ammunition, the mechanism will continue to operate as previously described.

Having thus described this invention, what is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In an ammunition supply system, the combination of an ammunition magazine comprising an endless carrier having a series of manually

loadable holders for individual rounds of ammunition, an electric motor, a power supply circuit for the motor, intermittent driving mechanism connecting the motor to the carrier, round transferring apparatus extending from said magazine to a remote delivery station, intermittent driving mechanism including a clutch connecting said motor to the transferring apparatus, a normally open switch in the motor power supply circuit, clutch disengaging means, and means responsive to movement of the clutch disengaging means for closing the switch to start the motor.

2. In an ammunition supply system, an ammunition magazine comprising an upright, motor driven, endless conveyor having a series of manually loadable holders for individual rounds of ammunition, a round transferer extending from the top of said magazine to a remote gun station; a round receiver at said station, a normally closed switch in the power supply circuit of the motor, a switch opener adjacent to the round receiver in position to be engaged by a round upon the receiver, to open said switch, and a separate, normally open, switch in the power supply circuit of the motor operable to supply power to the motor independently of the first-named switch.

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