PNEUMATIC CARTRIDGE FEEDER

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This invention relates to mechanisms for feeding cartridges, arranged in integrating link belts, into the receivers of automatic guns, and more particularly to such mechanisms which are independently powered and in which the feeding of each cartridge or round of ammunition is accurately controlled in response to the cyclic rate of the gun without diminishing effect on the optimum value of that rate.

Although large caliber automatic guns have been designed and developed to occupy an absolute minimum of space, their installation in aircraft has been difficult because of the large size and bulkiness of the combination including a feeder mechanism and a cartridge storage drum. To overcome this difficulty, it has become the accepted practice to assemble cartridges in a link type belt in which each successive cartridge operates as a pin connecting adjacent links together. The links, constructed to permit removal of the cartridges at right angles to the plane of the belt, separate after the cartridges are removed to accomplish disintegration of the belt.

While the use of belted ammunition avoids the need for the bulky storage drum and permits larger quantities of ammunition to be stored in more favorable locations, the mechanism for pulling the belt and placing each cartridge in the gun presents additional problems. As an attempt to solve these problems, two feeding mechanisms are in current usage. One of the mechanisms employs a pair of starwheels, or sprockets, adapted for driving engagement with successive cartridges assembled in the link type belt. Power sufficient to drive the starwheels for pulling the belt, stripping the cartridges from the links, and placing each cartridge in the gun receiver is supplied by a drive spring initially wound by a manual operation. As the gun is fired and the initial energy of the spring is used, that energy is restored by a complicated arrangement of clutches and levers which convert recoil and counterrecoil actions of the gun into rotary motion for winding the drive spring. The second feeding mechanism employs an electric motor as a source of power operating independently of the gun cycle to rotate the feed wheel for pulling the belt, stripping cartridges from the links, and placing each cartridge in the gun receiver.

Although the first of the above feed mechanisms employs power supplied by the gun and the second employs an independent source of power, both mechanisms add objectionable bulkiness to the profile of the gun. For this reason a gun equipped with either mechanism is difficult to install in confined quarters. Another objectionable feature characteristic of the above mechanisms is the lack of positive control over each cartridge after the cartridge has been stripped from the links. This feature results in the crowding of one cartridge on top of another whereby the free movement of the cartridge being chambered by the breech block of the gun is restricted sufficiently to lower the firing or cyclic rate of the gun.

Each of the above mechanisms is equipped with one or more slip clutches which, as is characteristic of such clutches, have the peculiarity of slipping when least desired. Any slippage of the clutch or clutches in the power train reduces the effective pull on the belt and thus creates objectionable conditions which lead to malfunctioning of the gun.

The present feeding mechanism eliminates the foregoing objections by providing a small, light-weight non-rotating, compressed air motor positioned across the gun receiver cooperating with a linkage of multiple pawls for pulling the belt, stripping the cartridges from the links, and placing each cartridge into the receiver in controlled response to the optimum cyclic rate of the gun.

The motor includes a piston actuated by air pressure of sufficient value to exert the required force for pulling the belt and stripping each cartridge from the links comprising the belt. A system of pawls, operating in response to the movement of the piston, positively controls the position of the cartridge in preparation for its chambering operation by the breech block.

Because of its many parts, the use of compressed air for performing various operating functions in military aircraft is rapidly becoming a universally accepted practice; hence the present invention follows this practice and provides an air-operated feeding mechanism which adds very little to the over-all height of the gun receiver, and makes possible the installation of completely equipped large caliber automatic guns in desirable but often restricted locations common to such aircraft. This improved feeding mechanism further enhances the adaptability of large caliber automatic guns to other types of military equipment in which available space for installation is limited.

It is, therefore, an object of this invention to provide a pneumatically operated device for moving a belt of cartridges toward the loading mechanism of an automatic gun.

It is another object to provide such a device whereby the belt of cartridges is moved in successive steps by a force intermittently applied in response to an empty condition of the loading mechanism of the gun.

It is another object to provide a pneumatically operated feeding device for advancing a belt of cartridges in successive steps toward the loading mechanism of an automatic gun, and for releasing a cartridge from the belt and directly feeding the same into chambering position in the gun loading mechanism in response to the absence of a cartridge from said gun loading mechanism.

An additional object is to provide such a feeding device in which the power for making each advancing step of the cartridge belt is independent of the recoil and counter recoil movements of the gun, so that each advancing step of the belt is effected immediately following the performance of a chambering operation by the gun loading mechanism.

It is another object to provide a cartridge feeder, for an automatic gun, in which a reciprocating fluid-operated motor is used, to move a belt of cartridges, and in which the motor can be stalled in any position of its reciprocating movement without damage to the feeder and, when stalled in any position, is always in condition to continue its normal operation after the cause of the stall is eliminated.

It is another object to provide such a feeder in which the reciprocating motor includes a valve mechanism that is balanced with respect to the fluid pressure which it controls.

It is another object to provide a cartridge feeder, for an automatic gun, which includes a feed throat for aligning a cartridge in position for chambering by the breech block mechanism of the gun.

It is also an object to provide such a feeder which includes power driven means for directly feeding a single cartridge into the feed throat in preparation for chamber-
ing by the breech block mechanism, and then forcing the cartridge into chambering position in front of the breech block mechanism when the breech block is withdrawn.

It is another object to provide a cartridge feeder for feeding a belt of cartridges toward the loading mechanism of an automatic gun, which feeder includes a reciprocating motor having means for feeding the belt combined with means for stalling the motor when the last cartridge in the belt has been chambered in the gun.

It is another object to provide a device for feeding a belt of cartridges to the loading mechanism of an automatic gun, which device includes means to prevent the advance of the belt while a cartridge is positioned in a feed throat associated with the loading mechanism.

The novel features which are believed to be characteristic of the invention, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only, and are not intended as a definition of the limits of the invention.

Fig. 1 is a perspective view illustrating the cartridge feeder mounted on the receiver portion of an automatic gun:

Fig. 2 is a cross sectional view of the cartridge feeder and gun receiver taken on a plane passing through the center of the pneumatic motor, line 2—2 in Fig. 3:

Fig. 2a is a fragmentary view of the motor valve triggering means;

Fig. 3 is a plan view of the motor portion of the feeder with fragmentary sections of the valve mechanism taken at different elevations;

Fig. 4 is a cross sectional view through the motor housing taken on line 4—4 in Fig. 3;

Fig. 5 is a fragmentary view illustrating the motor valve control mechanism in perspective;

Fig. 6 is a plan view of the feeding mechanism taken on a plane indicated by line 6—6 in Fig. 4;

Fig. 7 is a side elevation of the feeding mechanism taken on a plane indicated by line 7—7 in Fig. 6;

Fig. 8 is similar to Fig. 2 and illustrates the cartridge released from the belt;

Fig. 8a is similar to Fig. 2a;

Fig. 9 is similar to Fig. 8;

Fig. 10 is similar to Fig. 2a;

Fig. 10 is similar to Fig. 9 and illustrates the feeding mechanism returning to its position as shown in Fig. 2;

Fig. 10a is similar to Fig. 2a;

Fig. 11 is similar to Fig. 10;

Fig. 11a is similar to Fig. 2a;

Fig. 12 is similar to Fig. 2 and illustrates the means for stalling the motor when the last cartridge has been chambered;

Fig. 13 is a perspective view of a portion of the feeder illustrating the action of stripping a cartridge from the belt;

Fig. 14 is a fragmentary section of the gun and feeder illustrating a cartridge in position in front of the breech block mechanism ready for chambering;

Fig. 15 is similar to Fig. 14 and illustrates an empty cartridge case being ejected, and a live cartridge in readiness for chambering.

Referring to Fig. 1, a pneumatic cartridge feeder embodying this invention is indicated generally by reference numeral 20. Feeder 20 includes a feeder housing 22 having a base member 24, two identical end plates 26, a cover 28, and a reciprocating air motor 30 fixed to the cover and coupled to a source of compressed air 21 by a conduit 31. Feeder housing 22 is removably mounted on the receiver housing 33 of an automatic gun 32 by means of a bracket 34, fixed to the forward end of base member 24, and a pair of detachable tie rods 35 that anchor the feeder housing to a gun mounting cradle 36 to prevent longitudinal movement of the feeder under all conditions of gun and feeder operation. An inlet port indicated by arrow 38 is formed by an open side 22 whereby cartridges arranged in belt formation enter the cartridge feeder.

In Fig. 2, a portion of a disintegrating cartridge belt 40 made up of a series of cartridges 41, 42 and 43 is connected by metallic links 44 and 47. It is shown entering feeder 20 through inlet port 38 in preparation for the beginning of the cartridge feeding operation. The first cartridge 41, is placed ahead of a pair of latch members 48 and 49, of which the latter or aft latch member appears on Fig. 2, while both forward and aft latch members 48 and 49, respectively, appear in Figs. 1 and 13. These latch members are pivotally mounted on base members 24 by means of latch brackets 50 and 51, and a shaft 52. Each bracket, rigidly secured to the base member, rotatably supports shaft 52, while shaft 52 supports the latch members which are fixed thereto by suitably means such as set screws. The forward end of shaft 52 is also rotatably supported in tie rod bracket 34 which is riveted in position across the forward end of base member 24. A release lever 54 keyed to shaft 52 near its forward end provides means for manually depressing latch members 48 and 49 into the body of latch brackets 50 and 51 against the force of a spring 55 positioned between each bracket and its respective latch member, which spring normally urges its latch member into a cartridge engaging position as shown in Fig. 2, to prevent retrograde movement of the cartridge belt.

Cartridge belt 40 is advanced in a direction indicated by arrow 57 through inlet port 38 into feeder housing 22 by belt advancing paws 60 and 61 pivotally mounted on a shaft 62 fixed to downwardly extending flanges 63 and 64 formed as integral parts of a slidable driving plate 65 (see Fig. 6). A torsion spring 66 normally urges paws 60 and 61 downward into belt engaging position wherein the heel of each pawl bears against driving plate 65, as shown in Fig. 2, thus the paws assume a definite and fixed position for advancing the belt.

Power for moving slidable plate 65 is provided by reciprocating air motor 30 mounted on cover 28, which motor includes a housing 70 having a bore 71 in which a double acting power piston 72 is slidably disposed. Piston 72 includes a piston head 73 having opposed pressure responsive surfaces 74 and 75, an elongated skirt portion 76, and a bore 77 which extends coaxially through the skirt and terminates in the piston head to form surface 75. Around the outer circumference of skirt portion 76, flanges 78 and 79 are formed to provide guide members for piston 72 during its movement in bore 71, and to perform other useful functions to be described later.

Power piston 72 is moved to the position shown in Fig. 2 by air pressure applied to surface 75 of the piston through a tubular member 80 coaxially aligned with bore 77. One end of member 80 is fixed to motor housing 70, while the other end, sealed against the loss of pressure from the bore by an O-ring seal 81, is slidably positioned within bore 77 to allow piston 72 to slide with respect to member 80 when piston 72 moves in bore 71. Motor housing 70 is provided with a compressed air inlet chamber 83 and passageways 84 and 85 for interconnecting conduit 31 and tubular member 80, as illustrated in Fig. 3, where conduit 31 is shown threadedly connected to inlet chamber 83. Thus, compressed air flowing from chamber 83 through passageways 84 and 85, and member 80 is supplied to bore 77 and applied to the effective surface of piston head 73.

Movement of piston 72 in the direction indicated by arrow 86 (Fig. 2) to the position shown in Fig. 9 is accomplished by air pressure applied to surface 74 of the piston head through a balanced control valve
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2,857,818 5 90, the latter comprising a valve bore 91 formed in motor housing 70, a valve piston 92 having lands 93 and 94 slidably disposed within bore 91, an opening 89 connecting valve bore 91 with inlet chamber 83, and a port chamber 96 which intersects valve bore 91 and bore 71. The disposed location of lands 93 and 94 on valve piston 92 is such that land 94 is positioned on the right hand side of opening 89, and land 93 is positioned on the left hand side of port chamber 96 when valve piston 92 is in the position shown in Fig. 2. Thus, a passageway interconnecting inlet port 83 and bore 71 is formed by opening 89, bore 91, and port chamber 96. Moving valve piston 92 in a direction indicated by arrow 98, Fig. 2, to the location shown in Fig. 9, positions land 94 farther to the right of opening 89, and positions land 93 to the right of port chamber 96 in bore 71. In this position land 93 effectively blocks the above-described passageway and opens a portion of the valve bore 91 to atmospheric pressure to provide an exhaust port for bore 71 through port chamber 96.

The balanced characteristic of valve 90 results from the construction of valve piston 92 in which each land is provided with packing, such as an O ring or the like, to prevent compression air leakage past the lands, and in which each land has a radial surface exposed to air pressure from inlet chamber 83. Since lands 93 and 94 have the same outside diameter, the effective areas of the radial surfaces are equal; therefore, opposing forces produced by air pressure in valve bore 91 against the radial surfaces of valve piston 92 are equal and cancel each other to balance the valve.

It is to be noted that bore 71 in motor housing 70 is considerably larger than bore 77 in power piston 72, consequently the effective area of surface 74 is considerably greater than the effective area of surface 75, thus, when highly compressed air of the same unit pressure is simultaneously applied to both surfaces, piston 72 will move in the direction indicated by arrow 86 with sufficient force to perform useful work. Slidable driving plate 65 is coupled to power piston 72 through a slot 89 in a portion of the wall of bore 71 by a lug 100 formed on the upper surface of plate 65, and flanges 78 and 79 on skirt portion 76 of piston 72. The annular groove formed on the skirt by flanges 78 and 79 receives lug 100 to provide a power transmitting connection to plate 65 whereby the action of piston 72, under the influence of air pressure applied to surfaces 74 and 75 of piston head 73, is transmitted to the plate and belt advancing pedals 60 and 61. When feeder 20 is in operation, air pressure is continuously applied to surface 75 of piston head 73, while air at the same pressure is intermittently applied to surface 74 under control of valve 90 in response to cyclical movement of power piston 72.

Although valve 90 is operated in response to cyclical movement of power piston 72, power for moving valve piston 92 is derived from energy stored in a spring by the power piston. Such an application of power permits the valve to be opened or closed instantly at the end of each stroke of the power piston. For operating valve 90 in this manner, a valve control mechanism indicated generally by arrow 110 is assembled in a cavity 112 formed in motor housing 70, as illustrated in Figs. 2 and 3. It is to be noted that valve bore 91 forms an opening in an end wall of cavity 112 to allow valve piston 92 to extend into the cavity for mechanical connection with the control mechanism.

Valve control mechanism 110 includes a slide member 114 having end flanges in slidable contact with the sides of cavity 112 and a back or web portion bearing against the bottom of the cavity; a valve piston operator 120 slidably disposed between the flanges on the web portion of member 114 (Fig. 4), and connected to a collar 95 on the end of valve piston 92 by a groove formed in one end of the operator (Figs. 2 and 3); a compression spring 130 including spring alignment buttons 131 and 132; and ears 134 and 138. Valve piston operator 120 is an elongated member, of rectangular cross-section, having a recess through one side of sufficient length, depth and cross section to accommodate spring 130 and alignment buttons 131 and 132, as shown in Fig. 2. An entrance to the recess is provided in each end of an elongated member to permit lugs 115 and 116, which project upward from the web of slide 114, to freely enter the recess and engage buttons 131 and 132 for compressing spring 130 between the buttons against one or the other ends of the recess.

Slide member 114 is coupled to power piston 72 through a slot 102 in a portion of the wall of bore 70 (diametrically opposite slot 99) by a lug 118 projecting downwardly from the web of member 114, which lug is alternately engaged by flange 79 and flange 104 on skirt portion 76 of piston 72. Attention is directed to the fact that a portion of flange 104 has been removed and that flange 104 is located near the middle of skirt 76, thus providing a space between flange 104 and lug 118, Fig. 2, and the same space between flange 79 and lug 118, Fig. 8. This space permits lost motion between the power piston and slide member 114 and limits the travel of the latter.

Ears 134 and 138 are provided to trigger the movement of valve piston operator 120 and the consequent movement of valve piston 92. The ears are pivoted on their respective pivot pins 135 and 139 which are threaded into the motor body and extend through one of the side walls of cavity 112, Figs. 3, 4 and 5. Each ear acts independently as a stop to prevent movement of operator 120 until power piston 72 has moved to its proper position. This stop action results from end to end engagement between each sear and a ledge 122 projecting from one side of the valve piston operator, as illustrated in Fig. 5, where a torsion spring 136 provides the force for setting each sear in stop position. One of the side flanges of slide member 114 is shaped to form a cam 117 for alternately disengaging ears 134 and 138 from ledge 122 by a wedging action between the sloped surfaces on the cam and corresponding surfaces on the ears when the slide member moves to the right or left.

Movement of power piston 72 in the direction of arrow 86, Fig. 1, will cause flange 104 to engage lug 118 and move slide member 114 which, in turn, causes lug 115 to engage spring alignment button 131 and compress spring 130 between buttons 131 and 132 to engage and wall of the recess in valve piston operator 120, which operator is prevented from moving by the engagement between sear 138 and ledge 122; a condition clearly illustrated in Fig. 5. Further movement of power piston 72 and slide member 114 causes further compression of spring 130 until cam 117 raises the end of sear 138 from its contact with ledge 122. At the instant sear 138 is lifted above the end of the ledge, the stored energy in spring 130 is suddenly released to instantly move valve piston operator 120 and valve piston 92 to close control valve 90, as shown in Fig. 9, and to permit sear 134 to snap behind ledge 122 (Fig. 9a). Closing valve 90 opens a passageway through port chamber 96 and a portion of bore 91 for exhausting compressed air from within bore 71, whereupon the air pressure which is continuously applied against surface 75 operates to move power piston 72 in the reverse direction to that indicated by arrow 86.

Because of this reversed movement of the power piston, flange 79 on skirt 76 engages lug 118 for moving slide member 114 to effect contact between lug 116 and spring alignment button 132 for compressing spring 130 from the other end, a condition made possible by the action of sear 134 against the mating end of ledge 122. Further movement of member 114 causes cam 117 to release sear 134 to permit spring 130 to instantly open control valve
90 and close the exhaust passageway by returning valve piston 92 to the position shown in Fig. 2, and to permit seal 138 to snap behind ledge 122 as indicated in Fig. 39. Referring to Figs. 2, 4 and 13, it is clear that the lateral projections 140 pass through the space between the guide bars and the strippers, which space is indicated by reference numeral 180. When plate 65 is moved by power piston 72 in response to the application of air pressure against face 74, belt advancing pawls 60 and 61 engage link 46, Figs. 2, in a manner better illustrated in Fig. 13, where the pawls are shown in contact with the double loops of link 47. Continued movement of the plate and pawls, advances belt 40 in the direction indicated by arrow 57, this causes the leading edges of wedge-shaped portions of link 178 and of link 179 of the stripper 176 and 177 to enter the space between lateral projections 140 of link 46 and cartridge 41 to begin the disintegration of the belt. The upper surfaces of the wedge portions bear against projections 140 and the lower surfaces of the wedge portions bear against cartridge 41 guiding its movement downward until it is free of the loops to enter the feed throat 174, as illustrated in Fig. 8, from which entering position the cartridge is forced deeper in the feed throat by the bridge section of the link, while the link is moving toward its position shown in Fig. 9.

After leaving the belt, and during its travel toward feed throat 174, cartridge 41 encounters, in its path of movement, two spring loaded control pawls and two spring loaded overload pawls. The control pawls, indicated by reference numeral 182, are attached to the lower surface of cover 28 as shown in Figs. 4 and 13. Each pawl is normally urged by a torsion spring 183 to a stopped position (Fig. 13) in which further clockwise movement about its pivot pin is prevented, but the pawl is free to move counterclockwise (indicated by arrow 184) against the force of the spring. Thus, cartridge 41, when entering feed throat 174 pushes pawls 182 out of its path by overcoming the force of springs 183. However, once the cartridge is in the feed throat, the pawls return to their normal position in Fig. 13 and prevent the cartridge from backing out of the feed throat.

Overfeed pawls 185 are mounted within cavities 186 formed in the bodies of strippers 176 and 178 through the lower surfaces of the wedge-shaped portions 177 and 179 as illustrated in Fig. 13, where part of wedge 179 is broken away to show the cavity and pawl arrangement. Each pawl, pivoted mounted on a pin 187 supported in the side walls of the cavity, is normally urged by a spring 188 in a clockwise direction to a stopped position (Fig. 2, where the top surfaces of upper 189 of the pawls are in contact with walls 190 of the cavities (see Fig. 13). When entering feed throat 174, cartridge 41 engages arms 191 of pawls 185 and thereby rotates the pawls in a counterclockwise direction against the forces of springs 188. This counterclockwise rotation swings arms 189 into the path of cartridge 42, as shown in Figs. 8 through 11, and 13, where they remain as long as a cartridge is in feed throat 174. In other words, when one cartridge is in the feed throat, pawls 185 prevent the entrance of a second cartridge until after the one cartridge has been chambered by the gun loading mechanism.

Stated briefly, both sets of pawls are spring biased across the path of a cartridge entering feed throat 174 and both sets of pawls are pushed aside by the cartridge as it is forced into the throat by the bridge section of the leading link of the belt, as indicated in Figs. 8, 9 and 13. When cartridge 41 has been forced to the required depth, control paws 182 spring back to their normal position to check backward movement of the cartridge, and arms 189 of overfeed pawls 185 swing into position for preventing the further advance of cartridge 42 and the lower surfaces of guide bars 150 and 151. This arrangement permits the guide bars to cooperate with the strippers in the matter of guiding the links toward link 46 as indicated in Figs. 39. Referring to Figs. 2, 4 and 13, it is clear that the lateral projections 140 pass through the space between the guide bars and the strippers, which space is indicated by reference numeral 180.

Returning to the description of driving plate 65, Figs. 6 and 7 further illustrate important features of construction such as guide bars 150 and 151 for retaining the slideable plate 65 adjacent the bottom of motor housing 70 (see Fig. 4). As illustrated in Fig. 6, laterally extending portions of plate 65 form ears 67 and 68 which slantly bear on the upper surfaces of guide bars 150 and 151, respectively, while the downwardly extending flanges 63 and 64 bear against the inside surfaces of the guide bars. Mounted beneath plate 65 and pivoted on a pin 153 supported by flanges 63 and 65, is a stop pawl 154 urged by a compression spring 155 into the position shown in Figs. 7 and 12, whereby movement of driving plate 65 in the direction of arrow 156 is stopped by the engagement between a laterally extending edge 157 of pawl 154 and stops 158 and 159 formed on the guide bars 150 and 151, when the last cartridge in belt 40 has been advanced by belt advancing pawls 60 and 61. The existence of cartridges in the belt is indicated by a finger 170 formed on pawl 154 and adapted to engage the cartridge belt for actuating the pawl against the force of spring 155 so that edge 157 passes beneath the ledges forming stops 158 and 159 when driving plate 65 is operating to move the belt as illustrated in Fig. 6.

At this point in the description of the invention a brief discussion of links 46 and 47 and their relationship with the cartridges will provide a better understanding of the subject matter that follows. The links clearly illustrated in Fig. 13 are conventional in design and are commonly used in disintegrating cartridge belts. Each link employs a double loop on one end connected by a bridge section to a single loop on the other end; the single loop of one link being adapted to fit between the double loops of a second link in coaxial relationship. A cartridge placed in the loops acts as a hinge pin for joining the links in tandem. By similarly joining additional links and cartridges, a cartridge belt of any desired length can be formed. The disintegrating feature of the belt is achieved by the loop construction of the link. In Fig. 2, the loops of links 46 and 47 extend a little more than half way around cartridges 41, 42 and 43; this arrangement permits a cartridge to be separated from the links in a downward direction through the open side of the loops. To provide for separation in this manner, each loop of the double loops includes a lateral projection 140, and each single loop includes side flange 142 which engage each loop of the double loops, whereby the double loops, when forced from the cartridge, force the single loop from the cartridge at the same time.

As illustrated in Figs. 2, 8 and 9, base member 24 of feeder housing 22 is provided with flanges 170 and 172 which extend downwardly into receiver housing 33 of gun 32. The flanges, being constructed with inwardly sloping ledges, form a trough or feed throat 174 for aligning a cartridge in position for chambering in the firing chamber of gun 32 by the breechblock mechanism 175 of the gun (see Fig. 14).

Cartridge belt 40 is disintegrated or separated into its component parts by strippers 176 and 178 having wedge-shaped portions 177 and 179, respectively, for prying the cartridges from the links and for guiding each cartridge so released into feed throat 174. As illustrated in Fig. 11 through 11, the lower curved surface of the wedge-shaped portions guide the cartridge into the feed throat, while Fig. 13 illustrates the manner in which the upper surface of the wedge-shaped portions guide the links over the top of strippers 176 and 178 toward a link chute 39 which operates as an outlet from feeder housing 22 for disconnected links such as link 45. Attention is directed to the spaced relationship between the upper surfaces of strippers 176 and 178, and the lower surfaces of guide bars 150 and 151. This arrangement permits the guide bars to cooperate with the strippers in the matter of guiding the links toward link 46 as indicated in Figs. 39. Referring to Figs. 2, 4 and 13, it is clear that the lateral projections 140 pass through the space between the guide bars and the strippers, which space is indicated by reference numeral 180.
belt 40 until after cartridge 41 has been removed from feed throat 174.

While power piston 72 is moving to drive cartridge belt 40 from the position illustrated in Fig. 2 to the position illustrated in Fig. 8, flange 104 of the power piston 72 has moved into contact with lug 118 of slide member 114 to begin the compression of spring 130 preparatory to the closing of control valve 90. During the time spring 130 is being compressed, cam 117 of slide member 114 is approaching rear 138 which is in contact with one end of ledge 122 of valve piston operator 120. Fig. 8a. By the time power piston 72 has moved to the end of its stroke, as illustrated in Fig. 9a, cam 117 has raised rear 138 to disengage the sear from its contact with ledge 122, Fig. 9a. At the instant of this disengagement, valve piston operator 120 closes control valve 90 and opens an exhaust port for the escape of compressed air within bore 71 in the manner previously described, and rear 134 snaps down into the path of ledge 122 under the force spring 136. Upon the closing of valve 90 and the simultaneous opening of an exhaust port for the escape of compressed air against surface 74 of power piston 72, the air pressure continuous applied to surface 75 of the power piston takes over for the return stroke.

In moving from the position shown in Fig. 2 to the position shown in Fig. 9, power piston 72 has moved driving plate 65 and belt advancing arms 60 and 61 which in turn have advanced cartridge belt 40 one step or a distance equal to the spacing between the centers of adjacent cartridges. The one-step movement of belt 40 has stripped cartridge 41 from the belt and placed it in feed throat 174 under control of arms 182, while cartridge 42 has been taken from behind forward and aft latch members 48 and 49 and placed in front of these members as illustrated in Fig. 9, a position previously occupied by cartridge 41 in Fig. 2. In making the advance, cartridge 42 passes over the top of the latch members by depressing them into openings provided in brackets 50 and 51 in the manner shown in Fig. 8. As a result of this procedure, the pins of the latch members 48 and 49 is to prevent retrograde movement of belt 40, while permitting forward movement when the belt is advancing. However, the cartridge belt may be manually moved in a retrograde direction by manipulating release lever 54 in Fig. 1 so as to rotate shaft 52 in a clockwise direction. Such a procedure is required when unloading the feeder.

After the return stroke of power piston 72 has begun, control of the cartridge in feed throat 174 passes from control arms 182 to a pair of cartridge feeding arms 200 and 202 illustrated in Figs. 4, 6, 7, 10, 11 and 12. The arms are pivoted at one end on their respective pivot pins 204 and 206 which project from guide bars 150 and 151, respectively, in the manner clearly disclosed in Figs. 6 and 7. Lugs 220 and 222 formed on the bottom of ears 67 and 68 of driving plate 65 (Figs. 6 and 7) are adapted to engage arms 200 and 202 against cam surfaces 201 and 203, both of which arms include a dwell 205, Fig. 7. Torsion spring 207 and 208, Fig. 6, continuously urges arms 200 and 202 upward for contact with lugs 220 and 222 along surfaces 201 and 203, or dwell 205 at the upper end of those surfaces. Under the influence of springs 207 and 208, arms 200 and 202 swing upward into clearance grooves 105 and 106 (Figs. 4 and 5) formed in motor housing 70, when driving plate 65 has moved driven plate 63, its lugs 220 and 222 moves to the end of its belt advancing stroke in Fig. 9.

On its return stroke, under the force exerted by compressed air acting against surface 75, power piston 72 returns driving plate 65, but after plate 65 has moved a short distance, lugs 220 and 222 on the plate contact cam surfaces 201 and 203 so that further return movement of the plate causes the lugs to move cartridge feeding arms 200 and 202 downward to engage cartridge 41 and force the cartridge deeper in throat 174 to a position on top of bolt 230 of the breechblock assembly of the gun loading mechanism, as shown in Fig. 10. Under this condition, cartridge 41 blocks further movement downward of arms 200 and 202, hence the return movement of driving plate 65 and piston 72 is halted. In other words, the cartridge feeding arms not only hold cartridge 41 in feed throat 174 on top of bolt 230, but they also operate to halt the return movement of driving plate 65 and power piston 72.

When the breechblock assembly indicated by reference numeral 232 of automatic gun 32 is withdrawn, as illustrated in Fig. 14, a rearward movement for the cartridge chambering operation, bolt 230 is also withdrawn from feed throat 174, as shown in Fig. 11. Thus, cartridge 41 is permitted to move to the bottom of the feed throat where it is held by cartridge feeding arms 200 and 202 in response to further movement of driving plate 65 and power piston 72, as seen in Fig. 11. Here, again, is a condition in which cartridge 41 blocks further downward movement of arms 200 and 202, and in which the return movement of driving plate 65 and power piston 72 is halted for a second time.

It is now apparent that driving plate 65 and power piston 72 cannot return to the position shown in Fig. 2, while a cartridge is in feed throat 174, in the manner previously stated, the purpose of the latch members 48 and 49 is to prevent retrograde movement of the feeding arms which in turn block the return movement of driving plate 65 by reason of the engagement between lugs 220 and 222, and surfaces 201 and 203 on feeding arms 200 and 202, respectively. However, when cartridge 41 is removed and chambered by bolt 230, the feeding arms can move downward sufficiently to permit lugs 220 and 222 to slide from surfaces 201 and 203 into dwells 205 which allow plate 65 and power piston 72 to complete their return stroke without imparting further downward movement to the cartridge feeding arms.

While power piston 72 moves from its position in Fig. 9 to the other positions in Figs. 10 and 11, flange 104 on the skirt of the power piston moves away from lug 118, and flange 79 (Fig. 10) moves into contact with lug 118 to begin the reversed operation of control valve mechanism 116, for opening control valve 90 in the manner previously described in connection with Fig. 5. Fig. 10a illustrates the relationship between sears 134 and 136, and ledge 122 of valve piston operator 120, as well as the fact that cam 117 is moving toward sear 134 during the return stroke of the power piston and the driving plate. Fig. 11a illustrates the position of lugs 220 and 222 with respect to lugs 220 and cam 117, when power piston 72 has reached the end of its return stroke and is in the position shown in Fig. 2.

During the return stroke of power piston 72 and driving plate 65, belt advancing arms 60 and 61 pivot counterclockwise about shaft 62 against the force of spring 66 as they pass over the top of cartridge 42 in the manner illustrated in Figs. 10 and 11. When the driving plate has reached the end of its return stroke, arms 60 and 61 are urged downward by spring 66 to the position shown in Fig. 2, in preparation for the next advancing step of cartridge belt 40. It is also to be noted that during the return stroke of driving plate 65, finger 170 of stop pawl 154 slides into position on top of the cartridge about to enter feed throat 174, which is cartridge 41 in Fig. 2, and cartridge 42 in Fig. 11. By moving to the position of a top of a cartridge, finger 170 rotates pawl 154 in a clockwise direction about pin 153 against the force of spring 155. This clockwise movement lowers laterally extending edge 157 below stops 158 and 159 of guide bars 150 and 151 to permit the next advancing step of cartridge belt 40. When the last cartridge in the belt has been chambered in the firing chamber of gun 32, finger 170 indicates this fact by not rotating pawl 154.
This latter condition permits laterally extending edge 157 of the pawl to engage stops 158 and 159 shortly after power piston 72 and driving plate 65 have started their belt advancing stroke, as illustrated in Fig. 12.

Fig. 14 illustrates cartridge 41 in the bottom of feed throat 174 with breechblock mechanism 175, including bolt 230, in position for moving the cartridge into the firing chamber of the gun; while Fig. 15 illustrates the withdrawal of the breechblock mechanism, the extraction of the empty case of cartridge 41, and the ready position of cartridge 42 near the bottom of the feed throat in preparation for chambering by the breechblock mechanism. Attention is directed to the fact that only one cartridge is shown in feed throat 174, since no more than one cartridge can enter the throat at one time.

When the gun loading mechanism is empty and feeder 20 is first loaded, or, in other words, when the first cartridge of a belt of cartridges is placed ahead of latch members 48 and 49, compressed air supplied to inlet chamber 83 by conduit 31 from a source of adequate air pressure will cause the feeder to automatically respond to the empty condition of the loading mechanism, by rolling such as to pull the bolt of cartridges, release a single cartridge from the belt, guide the released cartridge toward feed throat 174, and feed the released cartridge directly to a position in the feed throat on top of bolt 230 in preparation for chambering by the gun loading mechanism. With the cartridge on top of the bolt, feeder 20 stalls and its action is confined to holding the cartridge in this position. To charge the gun, or place it in condition for firing, the breech block assembly is withdrawn from its forward position by a force applied externally of the gun. This action moves bolt 230 from under the cartridge, whereupon feeder 20 instantly operates to force the cartridge to the bottom of feed throat 174 and in front of the bolt in Fig. 14. At this point, the feeder stalls a second time and operates only to hold the cartridge in the bottom of the throat until forward movement of the breech block assembly chambers the chamber by pushing the cartridge out of the throat and into the firing chamber of the gun.

Chambering the first cartridge releases feeder 20 from its second stalled condition, whereupon the feeder automatically operates in response to the absence of a cartridge in the gun loading mechanism to move the cartridge belt another step, thereby releasing another cartridge which, like the first cartridge, is fed directly to a position in the feed throat on top of bolt 230 in preparation for chambering as described above. The operations performed by feeder 20 for placing the first cartridge in position for chambering are similarly performed for placing successive cartridges of the belt of cartridges in position for chambering. Except for chambering the first cartridge, the breech block assembly is automatically moved to its rearward position immediately after the gun is fired; resulting in automatic chambering of successive cartridges fed to the loading mechanism from the belt by feeder 20. When the breech block assembly has opened chamber step pawl 154 mounted on driving plate 65 functions to prevent further operation of the feeder.

It is accepted practice to provide a feed chute for guiding a belt of cartridges from a storage unit to an automatic gun; therefore, such a feed chute, which would normally be attached to feeder 20 for guiding belt 40 into position for entering inlet port 38, has been omitted from the drawings and the description for the sake of clarity. Occasionally, however, feed chutes become ineffective as an unobstructed path for the movement of the cartridge belt. Under such circumstances the belt becomes wedged or jammed preventing further movement thereof. When such jamming occurs, feeder 20 becomes stalled; furthermore, this stalled condition of the feeder is duplicated when the gun ceases to operate. In either case the stalled feeder consumes no power and wastes none of the compressed air from the source of compressed air because of the unique structure of the pneumatic motor and its control valve. Moreover, the feeder is always ready to continue its normal operation whenever the cause of the stall is corrected or removed.

What is claimed as new is:

1. A cartridge feeder responsive to an empty condition of the loading mechanism of an automatic gun for feeding a cartridge from a belt of cartridges directly into chambering position in the gun loading mechanism, said feeder comprising: reciprocating means responsive to the absence of a cartridge from the gun loading mechanism for effecting stepwise movement of the cartridge belt toward said loading mechanism such that each step corresponds to the linear spacing of the cartridges in said belt, said means including belt feeding pads adapted to driveingly engage the cartridge belt, a reciprocating fluid pressure motor adapted for alternately producing feed and return strokes of which the feed stroke is effective for moving the belt feeding pads one step toward the gun loading mechanism, and a fluid pressure control valve adapted for response to the motor feed and return strokes such that the feed stroke actuates said control valve for effecting the motor return stroke, and such that said return stroke actuates said valve for effecting the motor feed stroke; means responsive to stepwise movement of the cartridge belt for releasing a cartridge from said belt and for guiding the released cartridge into the gun loading mechanism; and means for directly feeding said re leased cartridge into chambering position in the gun loading mechanism and for holding said cartridge in readiness for a chambering operation by said loading mechanism, said direct feeding means being drivenly associated with the reciprocating means such that the return stroke of the fluid pressure motor is effective for feeding and holding action of said direct feeding means.

2. The cartridge feeder defined in claim 1 in which the reciprocating means and the cartridge feeding and holding means are provided with portions adapted for force transmitting engagement for effecting the driven association of said feeding and holding means with said reciprocating means, said portions being of a character such that the holding action of the feeding and holding means is effective for preventing completion of the return stroke of the fluid pressure motor until after the gun loading mechanism has performed the chambering operation on the cartridge held by said holding action.

3. A cartridge feeder for advancing a belt of cartridges and for feeding each cartridge from the belt directly into chambering position in the loading mechanism of an automatic gun having a receiver housing, said feeder comprising: a base member mounted on the receiver housing, said base member having a feed throat for aligning a cartridge in chambering position in the loading mechanism of the gun; a belt feeder attached to the base member, responsive to recurring absence of cartridges from the loading mechanism during cyclic operation of the gun for advancing the cartridge belt in stepwise steps toward the feed throat of said base member, said belt feeder including a source of compressed air, a reciprocable drive member having belt advancing pads, and a compressed air motor coupled to the drive member and constructed to alternately produce feed and return strokes in response to compressed air from said source for reciprocating said drive member in effecting stepwise movement of the cartridge belt; stripping elements mounted on the base member and responsive to each stepwise movement of the cartridge belt for releasing a cartridge from the belt and for guiding the released cartridge into the feed throat of said base member; and a cartridge feeding mechanism adapted for directly feeding the released cartridge into
chambering position in said feed throat and for holding said cartridge in readiness for chambering by the gun loading mechanism, said feeding mechanism being drivenly associated with the drive member of the belt feeder such that the feeding and holding actions of said feeding mechanism are effected by the compressed air motor in response to compressed air from the source during the return stroke of said motor, and such that completion of said motor return stroke is prevented until after the loading mechanism has chambered the cartridge being held by the feeding mechanism holding action.

4. The cartridge feeder defined in claim 3 which is further characterized by means for stopping the belt feeder motor when the last cartridge in the belt has been chambered by the gun loading mechanism, said means comprising a said receiver housing, said feeding system comprising: a base member mounted on the receiver housing, having a feed throat for aligning a cartridge in chambering position with respect to the gun loading mechanism; a cartridge belt feeder attached to the base member for advancing a cartridge belt in recurring steps toward the feed throat of the base member in response to recurring chambering operations of the gun loading mechanism, said belt feeder including a drive member with belt advancing fluids, a fluid pressure motor having a double-acting reciprocable power piston drivingly coupled to the drive member for providing said member with alternate feed and return strokes such as to effect the advancing steps of the cartridge belt, a source of fluid pressure for actuating the power piston, and a valve mechanism associated with said power piston and the power piston being operable to reciprocating movement thereof for controlling the actuating fluid pressure; stripping elements mounted on the base member, adapted for releasing a cartridge from the cartridge belt and for guiding the released cartridge into the feed throat of the base member in response to each stepwise movement of said belt; and cartridge feeding elements associated with the motor and the drive member such that the return stroke of said drive member is effective for directly feeding the released cartridge into chambering position in said feed throat and for holding said cartridge in said position, said feeding elements also constituting means whereby the return strokes of the drive member and the power piston are prevented until after the gun loading mechanism has chambered the cartridge being held in the chambering position in said feed throat.

7. The feeding system defined in claim 6 in which the double acting piston of the fluid pressure motor is characterized by opposed surfaces having different effective areas arranged such that the feed stroke of the drive member results from fluid pressure being applied to the piston surface having the larger area, and the return stroke of said drive member results from fluid pressure being applied to the piston surface having the smaller area.

8. The feeding system defined in claim 7 in which the fluid pressure motor includes a conduit adapted to provide a passageway for continuously directing pressure from the fluid pressure source to the piston surface having the smaller area for effecting the return stroke of the drive member; and in which the valve mechanism is characterized by means adapted to engage the piston such as to respond to piston movement at the end of the return stroke of the drive member for applying pressure from the fluid pressure source to the piston surface having the larger area for effecting the feed stroke of said drive member, and to respond to piston movement at the end of the feed stroke of the drive member for discontinuing fluid pressure application to the larger piston area so that fluid pressure continuously directed to the smaller piston area becomes effective to cause the return stroke of the drive member.

9. A cartridge feeder responsive to an empty condition of the loading mechanism of an automatic gun for feeding a cartridge from a belt of cartridges directly into chambering position in the gun loading mechanism, said feeding comprising: motor means having reciprocal feed and return strokes, drivingly associated with the cartridge belt such that the feed stroke is effective for causing the belt to move an advancing step toward the gun loading mechanism in response to the absence of a cartridge from chambering position in said loading mechanism; means for releasing a cartridge from the belt and for guiding the released cartridge into the loading mechanism in response to an advancing step of the belt; and means drivenly associated with the motor means for feeding said released cartridge directly into chambering position in response to the return stroke of said motor means, said feeding means being effective for holding the released cartridge in readiness for a chambering operation by the gun loading mechanism and for preventing further operation of the motor means until after said gun loading mechanism has performed the chambering operation on the cartridge being held by said feeding means.

10. A cartridge feeder responsive to an empty condition of the gun loading mechanism of an automatic gun for advancing a belt of cartridges toward the gun loading mechanism and for feeding a cartridge from the cartridge belt directly into chambering position in said loading mechanism, said feeding comprising: motor means having reciprocal feed and return strokes, drivingly associated with the cartridge belt such that the feed stroke is effective for causing the belt to move an advancing step toward the gun loading mechanism in response to the absence of a cartridge from chambering position in said loading mechanism; means for releasing a cartridge from the belt and for guiding the released cartridge into the loading mechanism in response to an advancing step of the belt; and means drivenly associated with the motor means for feeding said released cartridge directly into chambering position in said loading mechanism, said feeding comprising: motor means having reciprocal feed and return strokes, said motor means being adapted for driving association with the cartridge belt such that the feed stroke is effective for causing the belt to move an advancing step toward the gun loading mechanism in response to the absence of a cartridge from chambering position in said loading mechanism; means for releasing a cartridge from the belt and for guiding the released cartridge into the loading mechanism in response to an advancing step of the belt; and means drivenly associated with the motor means for feeding said released cartridge directly into chambering position in the gun loading mechanism and for preventing a further advancing step of the cartridge belt until after said gun loading mechanism has performed the chambering operation on the cartridge held by said feeding means.

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