N. GOODYEAR.

PNEUMATIC GUN.

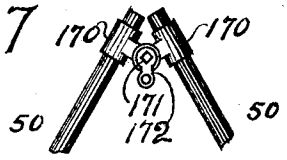
APPLICATION FILED FEB. 2, 1917.

1,324,772.

Patented Dec. 9, 1919.

4 SHEETS—SHEET 1.

Fig. 7



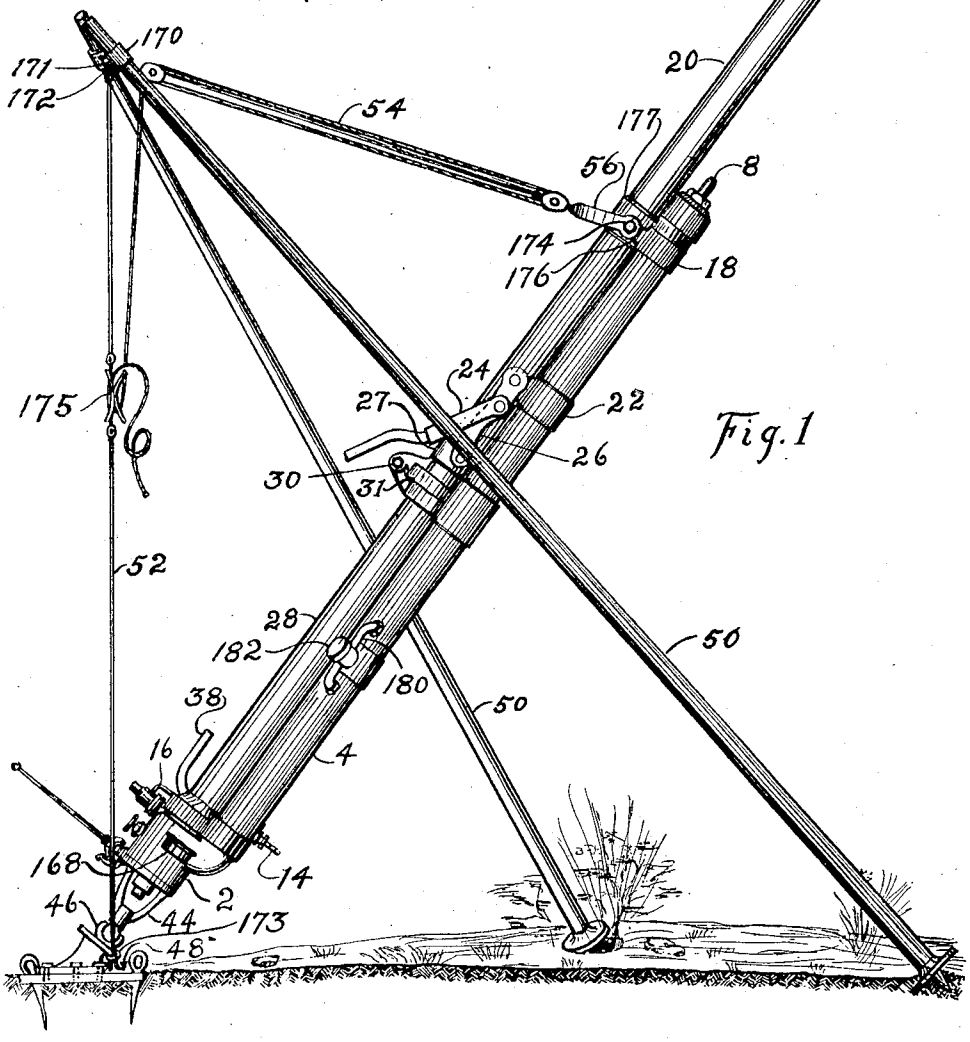


Fig. 1

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4 SHEETS—SHEET 2.

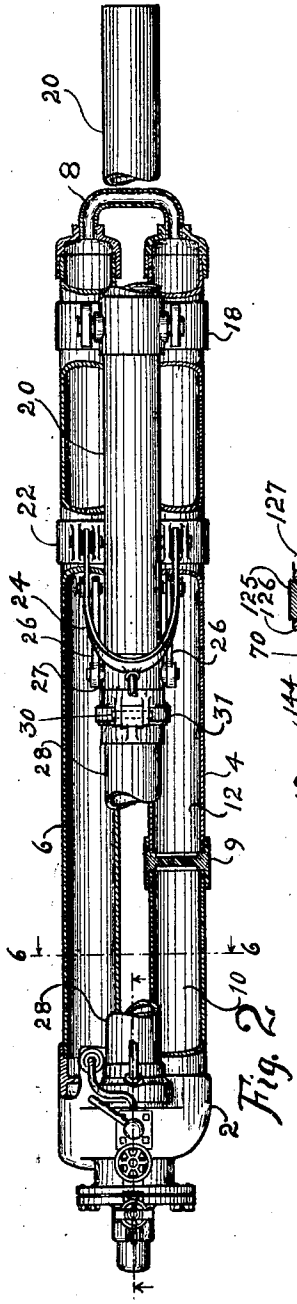

Fig. 2

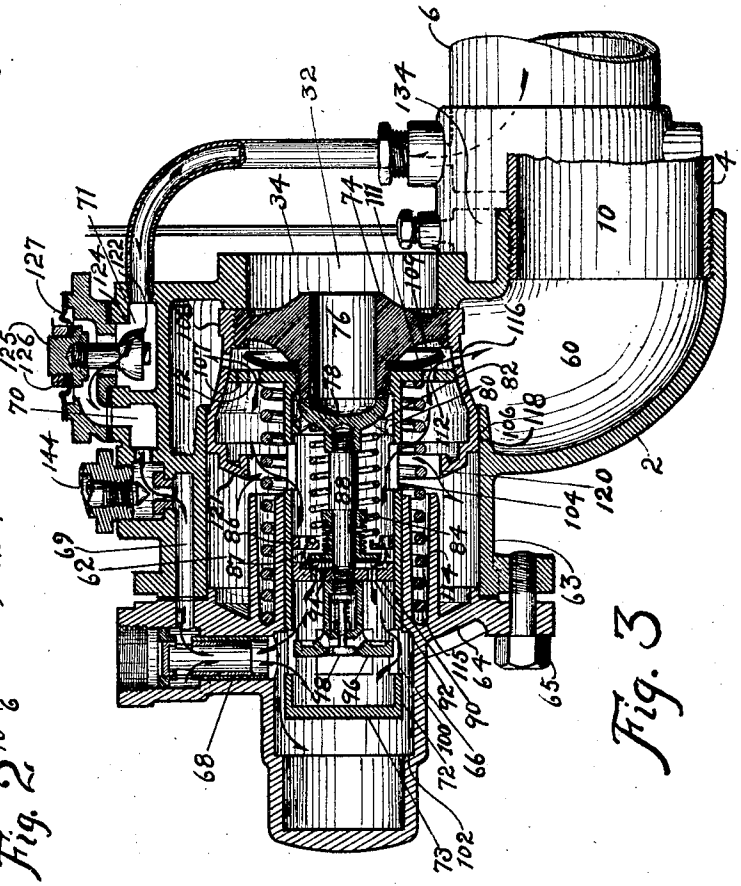

Fig. 3

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4 SHEETS—SHEET 3.

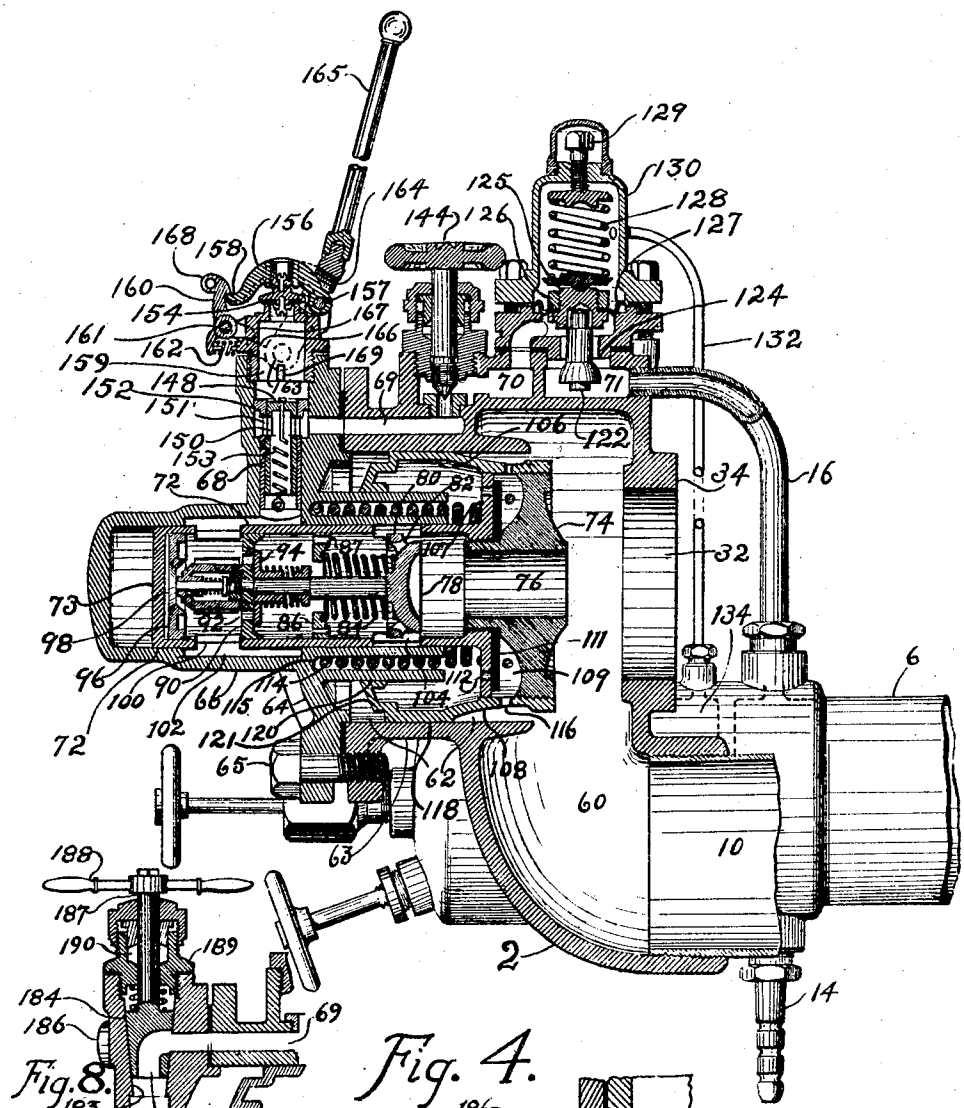

Fig. 4.

Fig. 8.

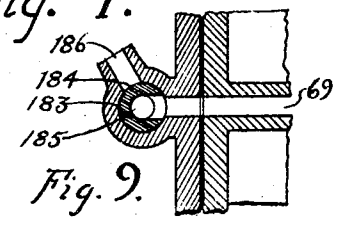

Fig. 9.

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4 SHEETS—SHEET 4.

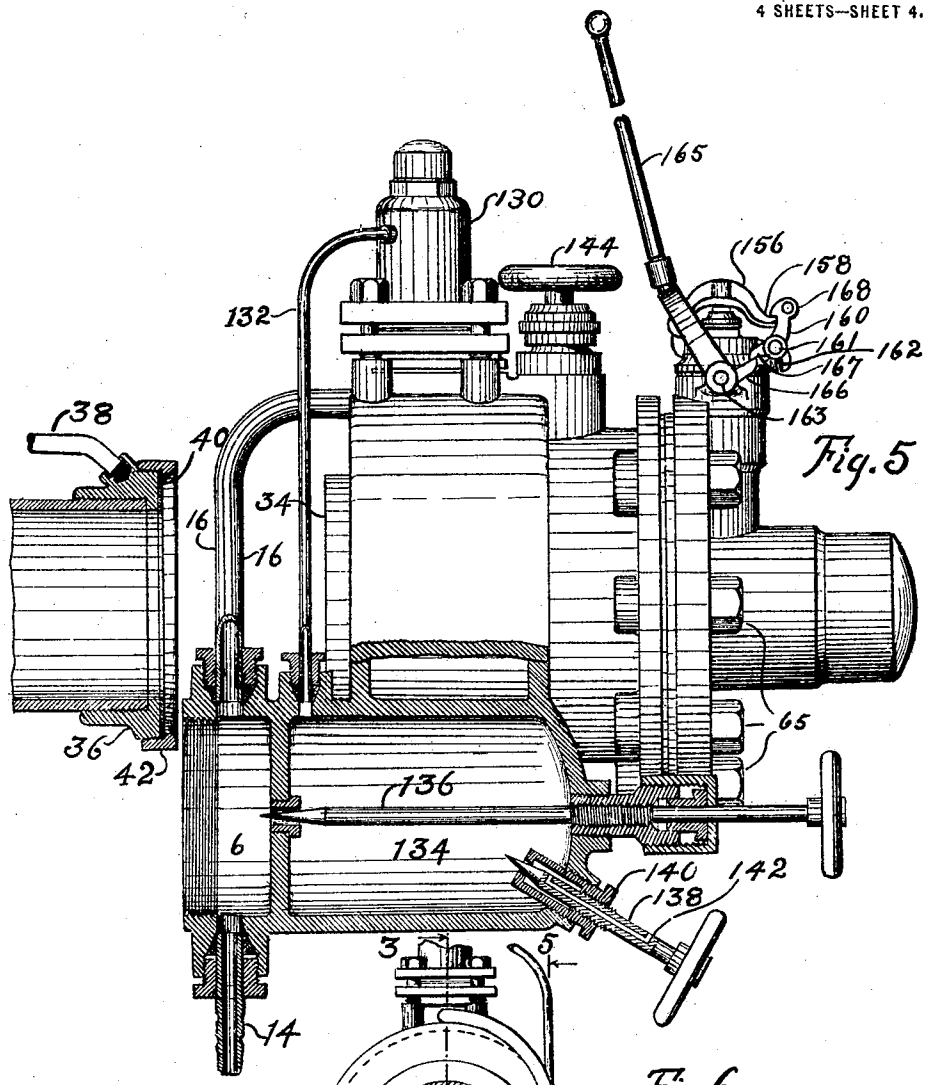
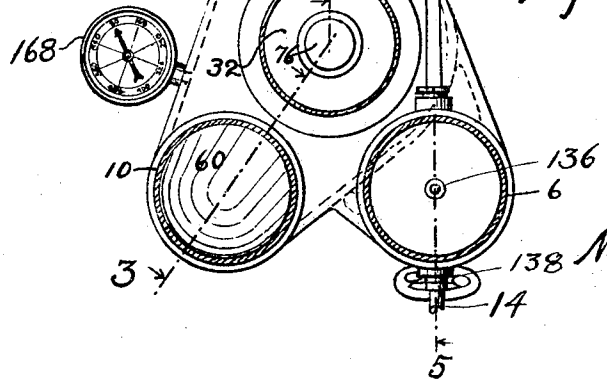


Fig. 5

Fig. 6



INVENTOR

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UNITED STATES PATENT OFFICE.

NELSON GOODYEAR, OF NEW YORK, N. Y., ASSIGNOR TO ORIN F. PERRY, SR., OF NEW YORK, N. Y.

PNEUMATIC GUN.

1,324,772. Specification of Letters Patent. Patented Dec. 9, 1919.

Application filed February 2, 1917. Serial No. 146,131.

To all whom it may concern:

Be it known that I, NELSON GOODYEAR, a citizen of the United States, residing at New York city, New York, have invented certain new and useful Improvements in Pneumatic Guns, of which the following is a clear, full, and exact description.

This invention relates to improvements in pneumatic guns, being more especially concerned with such devices of this kind as are used for throwing bombs and the like in trench warfare.

As is well known, it is the present practice to throw bombs and like missiles into the enemy's trench by hand, or by means of catapults.

In order that such missiles may be most effective in trench warfare it is necessary that they drop almost vertically directly into the enemy's trenches. To accomplish this, the missiles must be launched at a very high angle or trajectory which requires much greater energy for a given range than is required to attain the same range at a lower angle.

With my improved gun it is feasible to launch missiles at these higher and much more effective angles, to launch larger missiles and attain a considerably greater range than is possible by hand, and with less heavy and cumbersome apparatus than is possible by means of devices like the catapults of equal power. Moreover, the use of compressed air makes it possible to project missiles of a character which it would be impossible or dangerous to launch by other means, such for example, as missiles containing high explosives sensitive to shock or relatively fragile cases containing chlorin or other deadly gases.

There is this further advantage connected with the use of my new gun,—that the compressed air employed by it may be economically furnished by pumps driven by portable motor engines, of which various types have been perfected, or the pumps may advantageously be operated by utilizing some of the unemployed energy of the great number of idle men required to hold trenches.

While heretofore large and complicated pneumatic guns have been tried for throwing dynamite shells weighing many hundred pounds, no practical weapon of this character has been devised embodying the necessary portability and efficiency for trench warfare.

It is therefore an object of this invention to provide a bomb throwing gun of such a construction as to make possible increased rapidity of fire and accuracy in the control of the range over present methods. Further objects are to provide a gun of the kind specified which shall be compact and of relatively few parts, which may be mounted for action without the use of a heavy tripod or other cumbersome support and which shall be easily portable; to provide a pneumatic gun in which the length of barrel can be readily changed; to provide a pneumatic gun in which the air pressure that acts on the projectile is automatically controlled and to provide a firing mechanism not easily subject to accidental discharge, and which shall make possible the ecenomical and effective use of compressed air for discharging the projectile.

With these and other objects in view, I have devised as a preferred embodiment of my invention the construction shown in the accompanying drawings, in which—

Figure 1 is a view in elevation of the pneumatic gun in firing position;

Fig. 2 is a fragmental top view with portions broken away to more clearly show the underlying parts;

Fig. 3 is an ideal cross sectional view of the controlling and discharging mechanism on line 3—3 of Fig. 6, with the main valve in closed position;

Fig. 4 is a view similar to Fig. 3, with the main valve parts in the discharging position;

Fig. 5 is a side elevation partly in section on the line 5—5 of Fig. 6;

Fig. 6 is a transverse cross sectional view taken on line 6—6 of Fig. 2;

Fig. 7 is a front elevation of the connection for the two booms 50 of Fig. 1; and

Figs. 8 and 9 are sectional elevational and plan views of a modified form of firing valve.

In the drawings, 2 is a hollow housing, from which forwardly extend the metal tubes or cylinders 4 and 6. These cylinders are connected at their forward outer ends by the small bent tube 8. One of these cylinders has a partition 9 therein dividing it into two chambers 10 and 12. The rear

chamber 10 opens at its rear end into the hollow housing 2, as shown in Figs. 3 and 4, and is provided with a pressure gage 168 as shown in Fig. 6. The other chamber 12 communicates by means of the tube 8 with the cylinder 6, and forms therewith a compressed air reservoir chamber. The cylinder 6 is provided with a nipple 14 for attachment of the hose from an air compressor or the like. The cylinder 6 also communicates with the interior of the hollow housing 2 by means of a passage provided, in the form shown, by the pipe 16. Mounted on said cylinders 4 and 6 are collars 18 carrying supports 176 for the trunnioned ring 177 through which the barrel section 20 is adapted to slide. Other collars 22 pivotally carry the yoke 24, which is connected by the links 26 to a collar 27 detachably clamped around the lower end of said barrel section 20, said yoke and links forming a pair of toggles. Lower barrel section 28 is swingingly and detachably secured by the pivot 30 to the lower end of the upper barrel section 20, and fits into an annular socket 31. This provides for shortening the barrel when using the gun at short ranges. It will also be seen by loosening the collar 27 both barrels 20 and 28 may be separated from the other parts which division of weight is of considerable advantage in facilitating rapid transportation of the weapon from place to place.

The housing 2 has, in the forward face thereof, in alinement with said barrel, a discharge port 32 surrounded by a shoulder 34. The lower barrel section 28 is provided with a reinforcing member 36 carrying a handle 38, said reinforcing member adapted to rest on the shoulder 34 and being provided with a gasket 40 and a gasket-holding ring 42, said gasket-holding ring projecting rearwardly to surround said shoulder 34. The socket 31 on the barrel section 20 is formed by a reinforcing member and gasket-holding ring with gaskets exactly similar to the parts 36, 40 and 42 on the lower barrel section 28. By means of the yoke 24 and links 26 the barrel can be slid forwardly from the housing, thus permitting the lower barrel section 28 to be swung upwardly by the handle 38 for the insertion of the projectile, after which the barrel section 28 is lowered and then allowed to slide into place, the joint at the socket 31 and at the shoulder 34 being made air tight by the compression from swinging the yoke 24 into the locking position shown in Fig. 1.

If desired, the lower section 28 may be removed and the upper section 20 readjusted in the collar 27, to bring the socket 31 into position to be forced onto the shoulder 34 when the yoke is swung to lock the toggles.

On the rear end of the housing 2 is a bracket 44 having a ball and socket connection 46 with a plate 48 said plate being adapted to be secured in position on the ground by three or four iron stakes. Two light booms or poles 50 having their lower ends arranged to prevent slipping or sinking in the ground and joined at their upper ends with two collars 170 having perforated lugs fastened together with a bolt 171 carrying a shackle 172, see Fig. 7, are connected to an eye 173 in the plate 48 by a small cable 52. When used on approximately flat ground the bottom of the poles are set about their own length apart and the gun is swung between them by a small shackle 54, one block of which is attached to a bail 56, on the trunnions 174, and the other to the shackle 172, the loose end of the tackle line being fastened to the cleat 175, to support the gun at any desired elevation. It will also be seen that this method of support permits of a wide angle of horizontal train between the poles, does away with the necessity of any form of gun carriage or heavy tripod and also is adaptable to use in narrow trenches, shell holes or on uneven ground.

The housing 2 and cylinders 4 and 6 with the connecting passages, constitute a compressed air container; and the housing 2 is provided with means for controlling the distribution of the compressed air in said container and discharge it to fire the gun. This means will now be described, see Figs. 3, 4 and 5.

The inner end of the chamber 10 opens into the passage 60, in the housing 2; this passage is, in fact, a continuation of said chamber and forms therewith a firing charge chamber opening outwardly into the barrel through the discharge port 32. Rearwardly of said passage and coaxial with the opening 32 is a cylindrical recess 62 having its walls 63 forwardly extending into the passage 60.

The rear wall 64 of the housing 2 is detachably mounted thereon by the bolts 65 to permit its ready removal for the purpose of cleaning and repairing of the firing mechanism. The rear wall 64 is provided with a hollow cylindrical portion 66 extending forwardly into the cylindrical recess 62 and coaxial therewith. Opening into the cylindrical portion 66 is a passage 68, which extends through the rear wall 64 of the housing and is connected to the pipe 16 by the passages 69, 70 and 71.

Slidably mounted in the cylindrical portion 66 is a hollow cylinder 72 closed at the rear end by a wall 73 and carrying at its forward end the main valve 74 for which it serves as a hollow valve stem. The main valve 74 has a central passage 76 extending therethrough and opening at one end into

the cylinder 72 and opening at the other end, when the parts are in the position shown in Fig. 3, that is, when the main valve is closed, into the barrel of the gun. For closing the rear end of this passage there is provided an auxiliary valve 78, of less diameter than the interior of the cylinder 72 and carrying a guiding ring 80, fitting the cylinder 72 and secured to the valve 78 by spaced brackets 82. Spring 84 bears at one end against the valve 78, tending to keep it closed, the other end resting against the bracket 86 having perforations 87 therethrough to reduce the obstruction which the bracket offers to the passage of air through the cylinder 72. Said valve 78 is carried by the stem 88, to the rear end of which is screwed a disk which forms an auxiliary piston 90 slidable in the cylinder 72. The piston 90 is perforated at 92, and slidably mounted on the stem 88 is a spring pressed disk 94, which, with said perforations, forms a check valve. The threaded portion of the valve stem 88 is extended beyond said auxiliary piston and carries a plunger 96 adapted to coöperate with the rear end of the hollow cylinder 72 to form a recoil check for the valve 78 and attached parts; said plunger is provided with the check valve 98 to facilitate the forward movement of said plunger against the pressure of the air.

Adjacent its rear end, the cylinder 72 has a series of ports 100, the cylindrical member 66 being recessed at 102 to provide a passage between said ports 100 and the passage 68. A similar series of ports 104 is provided adjacent the front end of cylinder 72, said walls opening exteriorly into the recess 62 when the cylinder 72 is at its forward position, as shown in Fig. 3.

Carried by the main valve 74, is the main piston 106. This piston comprises a disk 107 and a rim member 108, said disk being mounted at the forward end of the cylinder 72 behind the main valve 74, the rear side of which curves away from the disk to provide a space 109 in which is mounted an annular disk 111 of rubber or other flexible or resilient material, which serves as a closure for the openings 112 in the disk 107 and forms therewith a series of check valves which permit a free passage of air into space 60 but prevent any passage of air backward from space 60 to the rear of piston member 107. Any other form of check valve found practicable might be substituted for this arrangement. The spring 114 bearing at one end against the rear side of disk 107, and having its opposite end mounted in a recess 115 in the cylindrical extension 66, acts to normally force the main valve 74 forward against its seat. The rim member 108 is screwed on to the periphery of the valve 74 and extends rearwardly therefrom having its intermediate portion bearing on the disk 107 in front of which it is provided with openings 116, which serve to connect the spaces 60 and 109. The rear end of the rim member 108 has a bearing surface 118 slidable on the walls 63 and is inwardly and rearwardly and then forwardly extended to provide a bearing surface 120 to slide on the outer surface of the forward portion of cylindrical member 66. The portion of the rim member between the bearing surfaces 118 and 120 forms a plunger 121, adapted to be received into the annular space 62 between the forward extension of the cylinder member 66 and the wall 63 forming a recoil check for the main valve 74. If found desirable this plunger may be provided with check valves. The rear end of the cylinder 72 with its wall 73 also forms a plunger adapted to be received into the rear extension of the cylindrical wall 66 and forming an additional recoil check for the main valve and its attached parts. A check valve may also be used if found desirable, admitting air into the space behind the wall 73 to facilitate the forward movement of cylinder 72.

The valves 74 and 78 are normally held in the position shown in Fig. 3, by the springs 84 and 114. When the parts are in this position, compressed air may enter from the passage 68, pass behind the rear end of the cylindrical member 72, through ports 100 into the interior thereof; behind and in front of the plunger 96, through the openings 92 in piston 90, forcing back the disk 94; then the air passes out of the cylinder 72 through the ports 104 into the recesses 62 filling the space behind the main piston 106, from which it passes through the openings 112 and 116 to the passage 60 and chamber 10. This passage of air continues until the pressure in the firing charge chamber is equal to that of the air entering through the passage 68.

As the air pressure behind the main valve 74 and in the chamber 10 increases, the valve will be held with correspondingly increasing pressure against its seat as there is only normal atmospheric pressure on the forward side of the main valve in the port 32 until the gun is fired, the pressure on the forward side of the piston rim 108 from the chamber 10 being balanced by the pressure in its rear. To regulate the pressure of the air supplied from the compressed air reservoir chamber to the passage 68 and thus to determine the pressure to which the firing charge chamber is to be charged, there is provided the reducing valve 122, actuated by a diaphragm 127 and coacting with the seat 124 interposed between the passages 70 and 71. The valve 122 is carried by a block 125 secured by a nut 126 to the flexible diaphragm 127 forming a part of the wall of passage 70. This valve is normally

held open by means of the spring 128 bearing on the block 125 and adjustable by means of the screw 129. The spring is contained in the air tight housing 130 closed at its lower end by the diaphragm 127 which is clamped in place thereby.

To supplement the pressure of the spring 128, compressed air is supplied to the upper side of the diaphragm through a passage 132 leading to the housing 130 from a compressed air chamber 134 carried by the housing 2 adjacent the inner end of the cylinder 6, (see Fig. 5). A needle valve 136 is provided for admitting air from the cylinder to the chamber 134, and a second valve 138, mounted in a sleeve 140 in the rear wall of the chamber 134 and having a duct 142 communicating with the interior of the sleeve and with the external atmosphere, serves as a means of reducing the pressure in the chamber 134. By appropriate manipulation of these valves, the action of the spring 128 may be supplemented by any air pressure between that of the atmosphere and that of the compressed air reservoir. The pressure in the firing charge chamber, and consequently the force with which the projectile will be discharged from the barrel when the gun is fired, is therefore capable of delicate adjustment between wide limits.

A hand operated valve 144 is provided for shutting off communication between the compressed air reservoir and the housing, as when it is desired to transport the gun or to repair the mechanism in the housing without emptying the reservoir. A similar valve may be provided for the inlet 14.

The arrangement for firing the gun will now be described. Mounted in the passage 68 is a cylindrical valve 148, open at its lower end and having ports 150, adapted to register with corresponding ports 151 in the sleeve 152, said slots 151 opening into the passage 69. A spring 153 tends to hold the valve 148 with its ports in alinement with the ports in the sleeve.

The outer end of the passage 68 is provided with a cap 154, adapted by means of suitable packing to hermetically close said passage; said cap is carried by a curved member 156 pivoted at one side on the housing 2 at 157 and having at the opposite side a lip 158 with which coöperates the latch 160, pivoted at 161 and having a spring 162 tending to force the latch toward latching position. Pivotally mounted at 163, see Fig. 5, to straddle the cap member 156 is a yoke 164, having a handle 165, and adapted when swung toward upright position to bear upon the curved top of the cap member 156 to press the cap in place. The lower ends of said yoke carry projections 166 for contact with projections 167 on the latch 160 to trip the same when the yoke is swung out of contact with the member 156. The latch may also be released by a lanyard fastened in the eye 168 in the latch.

There is a small amount of leakage between the top of the valve 148 and the sleeve 152, and the pressure in the space 159 in the passage 68, over the head of the valve 148, therefore equals that in passages 68 and 69 whenever the cap 154 is closed, when the spring 153 keeps the valve 148 down with the ports 150 and 151 in register in the position shown in Fig. 3. As soon, however, as the latch 160 is thrown out of latching position after the yoke 164 is swung out of contact with the member 156, the compressed air between the valve 148 and the cap 154 lifts the latter and escapes into the atmosphere. The pressure of the compressed air on the underside of the valve 148 then forces this valve upwardly until it strikes the stop 169 closing the slots 151 and bringing the slots 150 above the top of sleeve 152. The lower part of passage 68 is therefore cut off from the supply of air from the compressed air reservoir and put into communication with the atmosphere. The pressure behind the auxiliary piston 90 is therefore suddenly reduced to approximately atmospheric pressure, but as the disk 94 prevents the passage of compressed air from in front of said auxiliary piston head there is consequently an unbalancing of pressure on opposite sides of the piston 90 which is consequently forced backward, carrying with it the auxiliary valve 78 against the pressure of spring 84. It should be noted that the circular area of piston 90 is made considerably greater than the circular area of the valve 78 so that the pressure against the forward side of the piston 90 tending to force it back is correspondingly greater than the pressure tending to press the valve 78 forward against its seat. In the embodiment of the invention herein described the piston 106 is also made larger in circular area than the circular area within and including the valve seat to more quickly open the main valve as will be understood from the following, but this featue is not essential to the proper working of modified embodiments of the invention. As soon as valve 78 opens, the compressed air from between the auxiliary piston 90 and the main piston, together with compressed air behind the plunger 121, discharges through the passage 76 into the barrel of the gun, thus reducing the gage pressure behind the main piston to considerably below that in the firing charge chamber and equalizing the gage pressure behind the main valve and its piston 106 in front of the main valve in the discharging port 30, on the front of the piston 90 and on the rear of the projectile. The actual pressures tending to open the main valve will now be the difference in gage pressure between that in the chamber 10 and that in the space to the rear of the pis-

ton 106 multiplied by the difference in area between the circle within and including the main valve seat and the total circular area of the piston 106 plus the gage pressure in the rear of the piston 106 multiplied by the circular area of the outside of the cylinder 72 or far in excess of that required to overcome the pressure of the spring 114. The main valve therefore opens wide jumping back from the port 32 discharging the entire contents of the firing charge chamber 10 into the gun barrel 28 behind the projectile.

The opening of the cap 154 to release the air behind the auxiliary piston 9 is almost instantaneously followed by the opening of the valves 78 and 74 in rapid succession with the consequent discharge of the gun. Injury to the parts by the resulting shock is prevented by the cushioning effect of the air in the recoil checks between the rear end of the cylinder 72 and the rear end of the cylindrical extension 66, between the plunger 96 and the rear end of the member 72 and between plunger 121 and the rear end of the annular space 62. The arrangement of parts is such that the air in these spaces is rapidly raised to considerable pressure as it is confined behind the respective plungers.

By releasing the air from behind the main piston head into the barrel, the energy therein is utilized in discharging the gun and the only portion of compressed air wasted is the comparatively small amount between the auxiliary piston 90 and release valve or cap 154. Also this preliminary released air from the relatively small space behind the main valve starts the projectile forward overcoming its inertia more gradually than would an initial direct full blast from the firing charge chamber 10 thus permitting the use of projectiles sensitive to shock which it would be dangerous to discharge from other weapons.

The firing mechanism is reset by swinging forward the yoke 164 to force the cap 154 into place, the latch 160 automatically snapping over the lip 158. The parts thereupon will assume the position shown in Fig. 3; the compressed air flows from the compressed air reservoir through the housing until the air in the firing chamber is at the pressure for which reducing valve 122 is set. It is to be understood that in firing the gun, the yoke 164 is swung to release the cap and immediately swung backward to force the cap into closed position again. Action of the parts under the force of the compressed air being so rapid that it is unnecessary to leave the passage 68 open to the atmosphere any length of time, leakage of compressed air from the reservoir past valve 148 is therefore avoided.

The firing charge chamber 10 is provided with a gage 168, and is also provided with a by-pass 180 to the adjacent end of the reservoir, said by-pass having a hand-operated valve 182. By means of this by-pass, air may be admitted directly from the reservoir to the firing charge chamber or vice versa.

In the modified form of firing valve shown in Figs 8 and 9, a three-way valve arrangement is provided. Passage 68 is formed at its upper end into a tapered seat 183 in which is fitted a tapered valve head 184, having a passage 185 therethrough, one end of which opens downwardly into the passage 68, and the other end of which opens laterally through the side of the valve head, so as to register with the passage 69 or with a discharge opening 186, according to the position given to the valve head by means of its stem 187 and handle 188, said valve stem passing through a suitable retaining plug 189, provided with a customary stuffing box 190. A quick forward and reverse turn of the valve handle to bring the passage 185 momentarily in communication with the discharge opening 186 will result in a reduction of the pressure behind the auxiliary piston 90 sufficient to discharge the gun.

It is to be understood that my invention is not limited to the specific embodiment above set forth, but that to meet different conditions of use and operation there may be introduced such modifications, rearrangements and substitutions of parts and details thereof as come within the scope of the appended claims.

What I claim as new is:—

1. In a pneumatic gun, a barrel, means for supplying compressed air thereto comprising a compressed air container, a main valve between said container and said barrel, a piston in said container and carrying said valve and adapted to hold said valve closed when the air pressures on opposite sides of said piston are balanced, said gun being provided with a passage between said barrel and one side of said piston, an auxiliary valve for closing said passage, said auxiliary valve operable by reducing the pressure in a portion of said container, and means for reducing said pressure to open said valve and thereby release the air from one side of said piston and open said main valve.

2. In a pneumatic gun, a barrel, means for supplying compressed air thereto comprising a compressed air container, a main valve between said container and said barrel, a piston in said container and carrying said valve and adapted to hold said valve closed when the air pressures on opposite sides of said piston are balanced, said gun being provided with a passage between said barrel and one side of said piston, an auxiliary valve for closing said passage, said auxiliary valve provided with an auxiliary

piston and being adapted to be held closed when the pressures on opposite sides of said auxiliary piston head are balanced, and means for unbalancing said pressures to open said auxiliary valve and thereby release the air from said side of the main piston and open said main valve.

3. A pneumatic gun having in combination, a barrel, a firing charge chamber, a compressed air reservoir, an intermediate chamber having openings into said barrel, said firing chamber and said reservoir, and a piston in said intermediate chamber between the openings into said barrel and said firing chamber and the opening into said reservoir chamber, a valve controlled by said piston for normally closing the opening into the barrel, a check valve in said piston for admitting air from the reservoir to the firing chamber, and means for reducing the pressure on the side of the piston toward said reservoir chamber to permit the compressed air in the firing chamber to move said piston to open the valve.

4. A pneumatic gun having in combination, a barrel, a firing charge chamber, a compressed air reservoir, an intermediate chamber having openings into said barrel, said firing chamber and said reservoir, and a piston in said intermediate chamber between the openings into said barrel and said firing chamber and the opening into said reservoir chamber, a valve controlled by said piston for normally closing the opening into the barrel, a check valve in said piston for admitting air from the reservoir to the firing chamber, means for reducing the pressure on the side of the piston toward said reservoir chamber to permit the compressed air in the firing chamber to move said piston head to open the valve, said means comprising a passage between said side of the piston and the barrel of the gun, and a valve in said passage.

5. A pneumatic gun having in combination, a barrel, a firing charge chamber, a compressed air reservoir, an intermediate chamber having openings into said barrel, said firing chamber and said reservoir, and a piston in said intermediate chamber between the openings into said barrel and said firing chamber and the opening into said reservoir chamber, a valve controlled by said piston for normally closing the opening into the barrel, a check valve in said piston for admitting air from the reservoir to the firing chamber, means for reducing the pressure on the side of the piston toward said reservoir chamber to permit the compressed air in the firing chamber to move said piston to open the valve, said means comprising a passage between said side of the piston and the barrel of the gun, and a valve in said passage, said last named valve normally held closed by the pressure of air from said reservoir, and means for reducing said pressure to open said valve.

6. A pneumatic gun having a barrel, a firing charge chamber and a compressed air reservoir, means between the reservoir and the firing charge chamber for normally automatically maintaining the air in said chamber at a predetermined firing pressure, manually controlled means for shutting off communication between the reservoir and the firing charge chamber and for establishing communication between the firing charge chamber and the barrel.

7. A pneumatic gun having a barrel, a firing charge chamber and a compressed air reservoir, means between the reservoir and the firing charge chamber for normally automatically maintaining the air in said chamber at a predetermined firing pressure, manually controlled means for shutting off communication between the reservoir and the firing charge chamber and for establishing communication between the firing charge chamber and the barrel, said means including a plurality of valves, and manually operated means for causing the compressed air in said gun to operate said valves.

8. In a pneumatic gun, a barrel, means for closing the inner end of the barrel, said means comprising a main valve having a passage therethrough, an auxiliary valve for closing said passage, and pneumatic means for opening said auxiliary valve and said main valve in succession.

9. In a pneumatic gun, a barrel, a main valve for closing the inner end of said barrel and having a passage therethrough, means for controlling said main valve comprising an auxiliary valve in said passage, and pneumatic means for operating said auxiliary valve.

10. In combination in a pneumatic gun provided with a firing chamber for receiving a firing charge of compressed air, a barrel with which said chamber communicates, a main valve between said chamber and barrel, a housing for said valve, a piston in said housing, said main valve being secured to said piston and movable therewith, one side of said piston being subject to the pressure of the air in the firing chamber, means for supplying compressed air to the other side of the piston head, a check valve for permitting a portion of said compressed air to flow to the firing chamber but preventing flow in the opposite direction, means for discharging compressed air from said second main side of the piston directly into the barrel, thereby reducing the pressure on said second side of the piston and causing the piston head, under the influence of the pressure in the firing chamber, to open said main valve.

11. In combination in a pneumatic gun provided with a firing chamber for receiving

a firing charge of compressed air, a barrel with which said chamber communicates, a main valve between said chamber and barrel, a housing for said valve, a piston in said housing, said main valve being secured to said piston head and movable therewith, one side of said piston being subject to the pressure of the air in the firing chamber, means for supplying compressed air to the other side of the piston, and means for permitting a portion of said compressed air to flow to the firing chamber but preventing flow in the opposite direction, automatic means for limiting the pressure to which said firing chamber is charged.

12. In combination in a pneumatic gun provided with a firing chamber for receiving a firing charge of compressed air, a barrel with which said chamber communicates, a main valve between said chamber and barrel, a housing for said valve, a piston in said housing, said main valve being secured to said piston and movable therewith, one side of said piston being subject to the pressure of the air in the firing chamber, means for supplying compressed air to the other side of the piston, means for permitting a portion of said compressed air to flow to the firing chamber but preventing flow in the opposite direction, said main valve having a passage therethrough communicating with the barrel and with the second main side of the piston, a pneumatically controlled auxiliary valve for normally closing said passage, manually operated means for varying the air pressure controlling said auxiliary valve to open the same.

13. In a pneumatic gun, a barrel, a compressed air container comprising a firing charge chamber and a reservoir and a hollow housing opening into said barrel, said firing charge chamber and compressed air reservoir, a valve in said housing for closing the opening into said barrel, a piston carried by said valve and interposed between said firing charge chamber and reservoir, said piston being provided with a check valve for permitting air to flow therethrough to said firing chamber, a hollow stem for said valve, said stem interposed between said piston and reservoir and having one set of openings toward said reservoir, and another set of openings toward the space in said housing behind said piston, said valve having a transverse passage therethrough opening at opposite ends into said barrel and said valve stem, an auxiliary valve in said hollow valve stem for closing said passage, a stem for said valve, an auxiliary piston fitting on said auxiliary piston valve stem and adapted to slide between said sets of opening, to open and close said auxiliary valve, and having a check valve permitting compressed air to pass through said hollow valve stem from said reservoir to the space between said main and auxiliary piston, and an adjustable automatic pressure regulating valve between the hollow valve stem and the reservoir chamber, a manually controlled firing valve between the pressure regulating valve and the hollow valve stem, whereby the pressure on the adjacent side of the auxiliary piston may be reduced, thereby causing said auxiliary valve to be opened by the pressure of the compressed air between said main and auxiliary piston to discharge said air into the barrel of the gun, thereby permitting said main valve to be opened by the pressure of the air in the firing chamber upon the piston, to discharge said air into the barrel of the gun.

14. A pneumatic gun having a firing charge chamber and a compressed air reservoir, a pressure regulating valve between said chamber and reservoir, and pneumatic means for regulating the pressure at which said valve operates.

15. A pneumatic gun having a firing charge chamber and a reservoir, a pressure-regulating valve between said chamber and reservoir, said valve comprising a diaphragm exposed at one side to the pressure of the air in said firing chamber, and pneumatic means for regulating the pressure on the other side of the diaphragm, comprising a compressed air chamber communicating with said other side of the diaphragm, and means for adjusting the pressure in said last named chamber.

16. In combination, in a pneumatic gun, a housing, a barrel opening into said housing and extending forwardly therefrom, a pair of hollow cylinders extending forwardly from said housing and opening thereinto at their inner ends, one of said cylinders having a transverse partition therein providing a firing charge chamber at the inner end of said chamber, the outer portion of said cylinder opening into the other cylinder to form a compressed air reservoir, and means in said housing for controlling the flow of compressed air from the reservoir to the firing charge chamber and from said chamber to said barrel.

17. In combination in a pneumatic gun, a housing, a barrel opening into said housing and extending forwardly therefrom, a pair of hollow cylinders extending forwardly from said housing and opening thereinto at their inner ends, one of said cylinders having a transverse partition therein providing a firing charge chamber at the inner end of said chamber, the outer portion of said cylinder opening into the other cylinder to form a compressed air reservoir, means in said housing for controlling the flow of compressed air from the reservoir to the

firing charge chamber and from said chamber to said barrel, and means on said cylinder for slidably supporting the barrel.

18. In a pneumatic gun, a housing, compressed air casings extending forwardly from said housing, a barrel slidably carried by said casings, said barrel comprising an upper portion and a lower portion pivoted thereto.

19. In a pneumatic gun, a housing compressed air casings extending forwardly from said housing, a barrel slidably carried by said casings, said barrel comprising an upper portion and a lower portion pivoted thereto, said housing containing means to control the discharge of air from said casings into said barrel.

Signed at New York city, New York.

NELSON GOODYEAR.

Witness:
ABRAM BERNSTEIN.