July 19, 1960 C. N. WEBBY 2,945,487

AIR GUNS

Filed Sept. 16, 1957 2 Sheets-Sheet 1

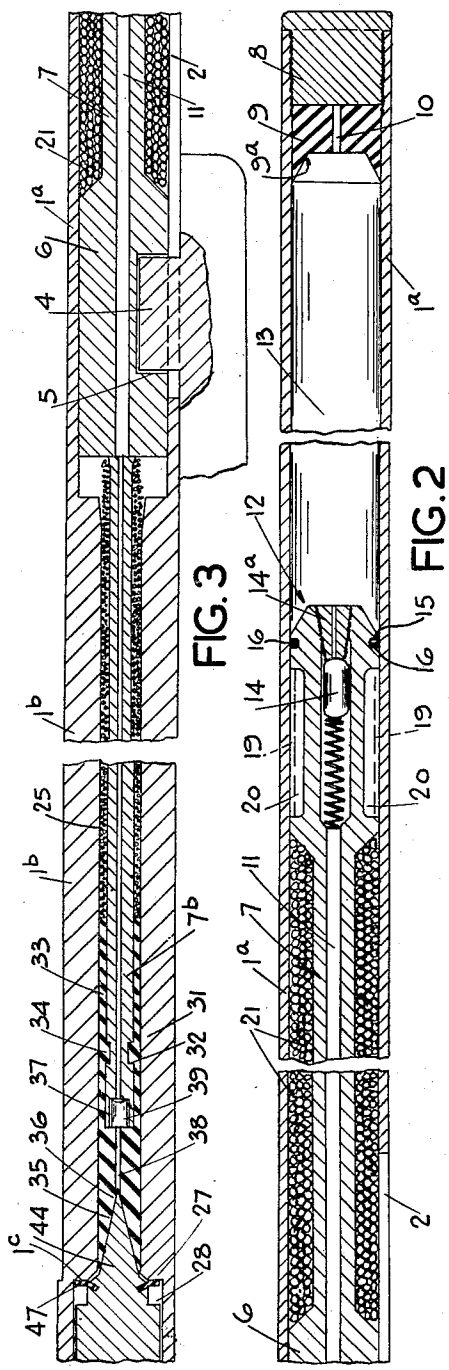

FIG. 3

FIG. 2

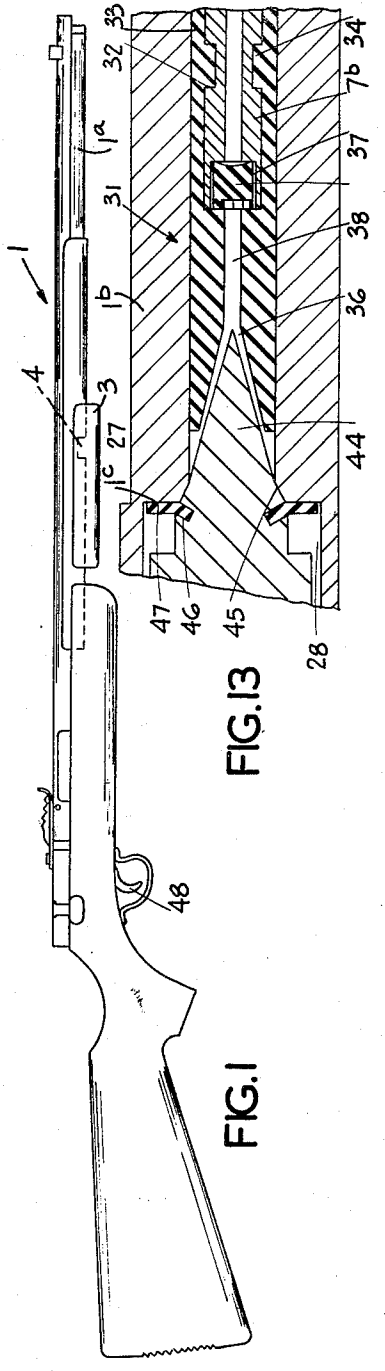

FIG. 13

FIG. 1

INVENTOR
CLIVE NELSON WEBBY
BY Whittemore, Hulbert & Belknap
ATTORNEYS

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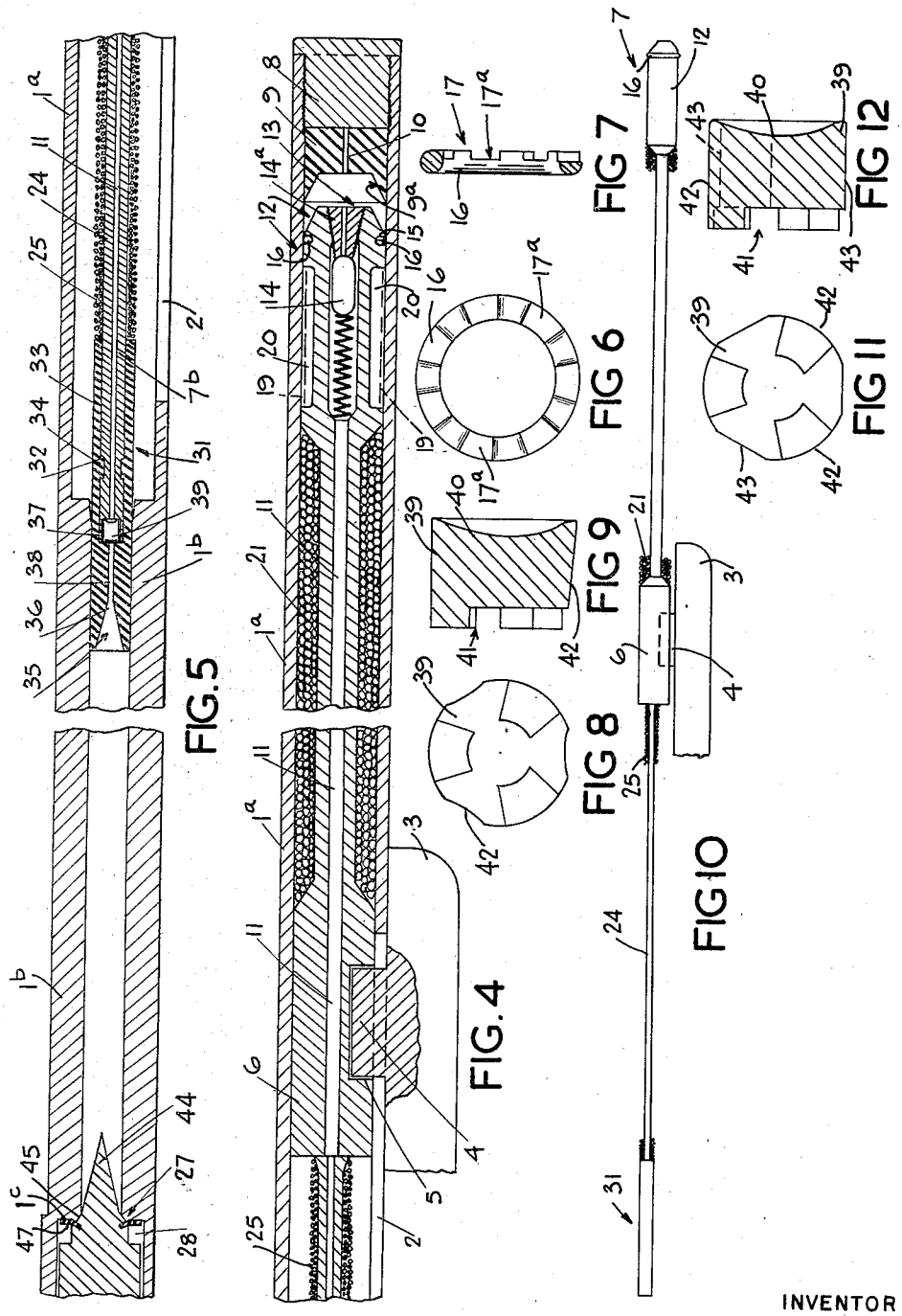

FIG. 5

FIG. 4

FIG 7

FIG 6

FIG 9

FIG 8

FIG 10

FIG 12

FIG 11

INVENTOR
CLIVE NELSON WEBBY
BY Whittemore, Hulbert & Belknap
ATTORNEYS

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AIR GUNS

Clive Nelson Webby, Riverlea, Taranaki, New Zealand

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5 Claims. (Cl. 124—13)

This invention relates to air guns and more particularly the invention has reference to air guns which are operated by a gas under pressure.

Prior to this invention, it has been known to operate air guns for the expelling of a shot from a barrel, by means incorporated in the gun for compressing a spring which on release of the spring engages or is cushioned by gas to move a shot and to expel the latter through the barrel of the gun.

Further, it has been known in air guns to provide hingeable means for operating a pump for pressing gas into storage, and to provide means for the release of gas under pressure to expel a shot through the barrel of the gun.

Further also, it has been known, in air guns, to provide a cartridge of compressed gas and to release part of the stored gas to expel a shot through the barrel of the gun.

It is an object of this present invention to provide improvements in an air gun including means for creating and for storing gas under pressure, said air gun including means for release of such gas or part thereof to expel a shot through a barrel of a gun.

The object of this present invention is to provide an improved means for pumping gas under pressure into a storage chamber, such pumping means being easily operated, convenient to the user or operator in holding the gun, and moreover a pumping means which requires little effort to gain the desired storage of gas for moving a shot through the barrel of the gun and expelling the shot therefrom, on release of some of the compressed gas or all of the compressed gas from the storage chamber for this purpose.

A still further object of this invention is to provide an improved means for the compressing of gas or for the storing of gas in an air gun, such means being not only simple to operate, but also durable in operation in that pumping is effected without the contacting and consequent wearing of the metal moving parts of a pump with other metal parts of a pump so that grit and other extraneous matter does not affect the operation of the gun, and wear between such parts is reduced to a minimum.

A further object of this invention is to provide in an air gun a construction which overcomes known difficulties associated with aligning or self centering a piston rod in a cylindrical casing when O rings and the like are used on a rod of small diameter as in previous constructions; in this invention, a resiliency in an inner piston head enables an inner end of the piston rod to align or self centre in the casing.

According to this invention, the improvements to an air gun comprises a cylindrical casing which is closed at its outer end and open at its inner end, and which is situated alongside and paralleling the barrel of the gun and held in association therewith, a storage chamber for gas under pressure arranged at the open inner end of the cylindrical casing, a piston rod reciprocal in the cylindrical casing, which is arranged to provide a low pressure chamber in its outer portion, the piston rod having an

outer piston head whereby reciprocation of the piston rod draws gas into the low pressure chamber and further reciprocation of the piston rod forces the gas past a low pressure non-return valve and along the interior of the piston rod to an inner piston head on the inner end of the piston rod, and such inner piston head is made of a durable flexible material with an inner high pressure check valve therein, and the inner piston head has a formed end which is slidably engaged on a valve head of a non-return valve of the storage chamber, so that gas is led through the inner piston head past its inner high pressure check valve and then past an inner non-return valve into the storage chamber.

This invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a genefal view of the air gun,

Figure 2 is an enlarged sectional view (partly broken) of the outer end of the cylindrical casing with the piston rod near the inner end of its stroke, and

Figure 3 is a continuation of Figure 2 showing the inner end of the cylindrical casing, while

Figure 4 is a view similar to Figure 2 showing the piston rod near the outer end of its stroke, and

Figure 5 is a continuation of Figure 4,

Figure 6 is a front view (further enlarged) of an O-ring, and

Figure 7 is a sectional view of Figure 6,

Figure 8 is an enlarged front view of one form of high pressure check valve, while

Figure 9 is a sectional view of Figure 8,

Figure 10 is a view (on a smaller scale) of the complete piston rod,

Figure 11 is an enlarged front view of another form of high pressure check valve, while

Figure 12 is a sectional view of Figure 11, and

Figure 13 is an enlarged sectional view of the inner piston head and high pressure check valve.

In this invention, an air gun generally indicated at **1** has a cylindrical casing **1***a* which is provided with a longitudinal slot **2** through which a hand piece **3** is arranged to reciprocate along the exterior of the cylindrical casing **1***a* and the hand piece **3** has a protuberance **4** passing through the slot **2** and the protuberance **4** engages in a small slot **5** near the central part **6** of the piston rod **7** within the casing **1***a* so that on moving the hand piece **3** reciprocally out and back along the cylindrical casing **1***a*, the piston rod **7** is moved within the interior of the cylindrical casing **1***a* (see Figures 1, 2 and 3).

As shown in Figure 2, the cylindrical casing is provided with an outer plug **8** which can be removed for placing the piston rod **7** in the cylindrical casing **1***a* and then the plug **8** is screwed on again to seal the outer end of the casing **1***a*. Situated in the casing **1***a* and adjacent the outer plug **8** is a buffer pad **9** which is formed with an end having an interior taper **9***a*, and a relief or bleed hole **10** is made through the buffer pad **9**.

In Figures 2 and 3, the piston rod **7** is illustrated near the inner end of its stroke and the piston rod **7** according to this invention (see Figures 2 and 3) is elongated and arranged with a central small bore **11** for the passage of gas therethrough. On the outer end of the piston rod **7**, near the outer plug **8** and facing the buffer pad **9**, is an outer piston head **12** formed on the outer end of the piston rod **7**, and such outer piston head **12** is tapered to fit into the interior tapered end **9***a* of the buffer pad **9**. A low pressure chamber **13** is formed between such outer end of the casing **1***a* with its buffer pad **9** and the outer tapered head **12** of the piston rod **7**. A low pressure non-return valve **14** is situated within the entrance of the bore **11** of the piston rod **7** and the valve **14** is retained within the outer tapered portion of the piston head **12** by a tapered screw threaded plug **14***a* (see Figures 2 and 4).

Towards the rear of the outer tapered head of the piston **12** and behind the tapered portion is formed an annular groove **15** in which is inserted a low pressure O-ring **16** which is a loose fit in the annular groove **15** (see Figures 2, 4, 6 and 7). The outer face **17** of the O-ring **16** i.e. the face of the O-ring **16** next to the tapered head **12**, is formed with checked out portions **17***a* or with raised portions or studs on and projecting out from such outer face **17**, so that gas can be drawn into the low pressure chamber **13** round and past the O-ring **16** whereas, gas from the low pressure chamber **13** can not in reverse, pass the O-ring **16** as the latter seals against the interior of the casing **1***a* and by its unbroken other face of the O-ring **16** against the inner part of the annular groove **15** (see Figures 6 and 7). Thus outward reciprocation of the piston rod **7** and its outer head **12** confines gas in the low pressure chamber **13** and the gas is forced past the low pressure non-return valve **14** in the entrance of the bore **11** of the piston rod **7**; and gas passes along the bore **11** towards the storage chamber as shown more particularly in Figure 4.

Further in from its annular groove **15**, the piston rod **7** has a sleeve **19** preferably of a rubber composition formed with longitudinal ridges **20** which run along and bear upon, the interior of the casing **1***a*, and the ridges **20** permit gas to pass lengthwise along the sleeve **19** to the outer tapered head of the piston **12** and to the low pressure chamber **13** (see Figures 2 and 4).

As shown in Figures 2, 3, 4 and 5, behind and further in from the outer tapered piston head **12** and back in from the sleeve **19**, the piston rod **7** is decreased in diameter and is bound round with an exteriorly and helically arranged oiling wick **21** such oiling wick **21** extending from the outer tapered piston head **12** to the central part **6** of the piston rod **7**.

The central part **6** of the piston rod **7** is enlarged in diameter and is formed with a small slot **5** made longitudinally of the piston rod **7**, and such small slot **5** is arranged and situated to provide for engagement of the protuberance **4** on the hand piece **3** whereby the piston rod **7** can be reciprocated in the casing **1***a*. For this latter purpose the casing **1***a* is provided in its central portion with the corresponding but longer longitudinal slot **2** to permit the protuberance **4** to project through and reciprocate along the longer longitudinal slot **2** (see Figures 2, 3, 4, 5 and 10).

As illustrated in Figures 3 and 5, commencing from the enlarged central part **6** of the piston rod **7** and continuing to the inner end of the piston rod **7**, this inner part **24** of the piston rod **7** is decreased in diameter again and bound round exteriorly and helically with a further oiling wick **25** which has a smaller diameter than the first-mentioned oiling wick **21**. Such further oiling wick **25** is arranged to strengthen and to guide the inner part **24** of the piston rod **7** in the cylindrical casing **1***a* to prevent buckling or flexing of this narrowed part **24** which is a sliding fit in the portion **1***b* of the cylindrical casing **1***a*.

The cylindrical casing **1***a* has an inner portion **1***b* with its bore reduced in diameter, and the piston rod **7** has an inner head arranged to operate in such reduced inner portion **1***b* of the cylindrical casing **1***a*, and a non-return valve **27** of a storage chamber **28** is arranged to operate against the inner end of such reduced inner portion **1***b*. Beyond the reduced inner portion **1***b*, the cylindrical casing **1***a* extends with its normal bore towards, and terminating near, the inner end of a barrel (not shown) of the gun **1**, that is the casing **1***a* continues beyond the non-return valve **27** to provide a passage from and alongside the non-return valve **27** to the storage chamber **28** (see Figures 3 and 5).

As shown in Figures 3 and 5, the inner end of the piston rod **7** is formed to receive and to hold an inner piston head **31** which is an essential part of this invention.

As shown in Figures 3 and 5, and more particularly in Figure 13, in order to receive and to hold the inner piston head **31** on the inner end portion **7***b* of the piston rod **7**, such inner end portion **7***b* has its exterior surface formed with an annular groove **32**, and the inner piston head **31** has a skirt **33** which is a firm push fit over the inner end portion **7***b*, and the skirt **33** is stretchable over said inner end portion **7***b* until an interiorly raised portion **34** of the skirt **33** fits into and holds in the annular groove **32**, to ensure the gripping of the skirt **33** on the inner end portion **7***b* of the piston rod **7**, so as to prevent loss of low pressure gas and to prevent buckling and distortion of the skirt **33** by frictional contact.

The inner piston head **31** is made of a rubber composition and one which is of a material which does not deteriorate in the presence of oil, and which does not seize on the interior wall of the cylindrical casing **1***a*, and the rubber composition may be reinforced or progressively hardened from a bell mouth **35** to the skirt **33**.

The outer end of the skirt **33** of the inner piston head **31** is flared in the form of a bell mouth as an oil scraper ring to restore oil.

The inner piston head **31** has a tapered hole **36** which tapers and splays towards the non-return valve **27** of the storage chamber **28**, so that the inner piston head **31** is provided with flexible lips. The inner piston head **31** has a denser body portion than the flexible lips of the inner piston head **31**, and the flexible lips can be flexed under the pressure of gas being pumped to seal off an escape line for the compressed gas (see Figure 13).

The outer end of the inner piston head **31** situated about the inner end portion **7***b* of the piston rod **7** is in the form of a skirt **33** or annular wall which serves as a guide on the reduced portion **1***b* of the cylindrical casing **1***a* to prevent whipping of the inner reduced portion **24** of the piston rod **7** as well as for holding the inner piston head **31** on the inner end **7***b* of the piston rod **7** by engaging in the annular groove **32** in the inner end of the piston rod **7***b* as outlined above, and as illustrated in Figures 3, 5 and 13.

As shown in Figures 3, 5 and 13, behind the denser body portion of the inner piston head **31** there is provided a high pressure valve chamber **37**, and the high pressure valve chamber **37** is open to a passage **38** through the denser body portion leading to the tapered hole **36**. Such high pressure valve chamber **37** in one form as illustrated is made between the surface of the denser body portion and the inner end **7***b* of the piston rod **7**; and the inner end **7***b* of the piston rod **7** is hollowed or cut out concentrically of the bore **11** of the piston rod **7** so that the high pressure valve chamber **37** is a recess in the inner end **7***b* of the piston rod **7**.

The arrangement of the piston rod **7** is such that the inner end of the bore **11** of the piston rod **7** terminates in the high pressure valve chamber **37** (see Figures 3, 5 and 13).

A check valve **39** suitable for gas under pressure is situated in the high pressure valve chamber **37** and such check valve **39** has a concave end **40** which fits over the inner end **7***b* of the bore **11** of the piston rod **7**, which terminates in the high pressure valve chamber **37**, and the concave end **40** of the check valve **39** forms a seal around the piston rod bore **11** as required during the operation of the device (see Figures 3, 5 and 13).

In this invention and as illustrated in Figures 3, 5, 8, 9, 10, 11, 12 and 13, the check valve **39** is castellated or otherwise formed at its other end **41**, and such castellated end **41** bears against the denser body portion of the inner piston head **31**, and over the passage **38** which leads to the tapered hole **36** of the inner piston head **31**. The check valve **39** is in the form of a solid cylinder and in one form the walls **42** of the valve **39** are tapered towards the castellated end **41** (Figures 8 and 9) whilst in another form the walls **42** are provided with flats **43** (Figures 11 and 12). By this arrangement gas being pumped enters the high pressure valve chamber **37** and the concave end **40** gives a feather cut-off to the inner

end of the bore 11 of the piston rod 7 and the gas passes around the exterior of the check valve by the tapered walls 42 or by the flats 43 to and through the passage 38 through the denser body portion of the inner piston head 31 to the tapered hole 36, during the operation of the device.

Such tapered bore of the inner piston head 31 therefore assumes the construction of a bell mouth 35 whereby gas being compressed forces the bell mouth 35 outwards against the bore of the reduced inner portion 1*b* of the cylindrical casing 1*a* to form an initial seal against the back pressure of the compressed gas as it is compressed in the storage chamber 28. The outer surface of the bell mouth 35 of the inner piston head 31 is a slip fit in the reduced inner portion 1*b* of the cylindrical casing 1*a* and such outer surface forms an initial seal in the casing 1*a*. At the same time the gas under pressure from the storage chamber 28 expands the body portion of the inner piston head 31 outwards about the tapered hole 36 and more particularly about the high pressure valve chamber 37 to ensure that the inner piston head 31 fits the reduced inner portion 1*b* of the cylindrical casing 1*a* and bars the escape of gas under pressure from the high pressure valve chamber 37 which is the normal escape route for gas being compressed into the high pressure valve chamber 37, so that the gas under pressure is forced into the storage chamber 28. Due to the resilience of the connection between the skirt 33 and the denser body portion having the bell mouth 35, the said denser body portion enables the inner end 7*b* of the piston rod 7 to be self-aligning in the reduced inner portion 1*b* of the cylindrical casing 1*a* during reciprocation of the piston rod 7. (See Figures 3, 5 and 13.)

The tapered portion of the inner piston head 31 is arranged to fit over a male part of the valve head 44 of the non-return valve 27 of the storage chamber 28. This valve head 44 has a bevelled sealing surface 45 making a seal on the complementary bevelled sealing surface made in the reduced inner end portion 1*b* of the cylindrical casing 1*a* and the valve head 44 has an annular groove 46 alongside the bevelled sealing surface 45 so that a sealing ring 47, which is accommodated and held in the anular groove 46, bears against the flat inner end 1*c* of the reduced portion 1*b* of the cylindrical casing 1*a* to make a seal to ensure that gas under pressure from the storage chamber 28 will not return to the inner piston head 31. Thus gas under pressure passing through the passage 38 in the inner piston head 31 presses on the male part of the valve head 44 of the non-return valve 27 of the storage chamber 28, until the valve head 44 is forced off its seat and the gas is forced past the sealing ring 47 which does not permit the gas to return from the storage chamber 28 to the passage 38 in the inner piston head 31. The valve head 44 may be cut away or recessed or provided with an annular checked out portion alongside the annular groove 46 whereby gas under pressure is received and is also permitted to pass inwards to the storage chamber 28 for gas under pressure behind the valve head 44.

At the inner end of the cylindrical casing 1*a* behind the storage chamber 28 there is provided a releasing means (not shown) operated by a trigger 48 of the gun 1 and such release gear is arranged to operate a releasable piston (not shown) which permits the gas under pressure to escape into the barrel of the gun 1 for the purpose of propelling or expelling a shot from the gun 1 on firing the latter.

Hence in carrying out this invention and preparatory to firing or expelling a shot from a gun 1, gas under pressure is built up in the low pressure chamber 13, transferred to the high pressure chamber 37 and stored in the storage chamber 28. Such build up of gas under pressure is effected by sliding the hand-grip 3 reciprocally along the cylindrical casing 1*a* of the gun 1, the cylindrical casing 1*a* surrounding the piston rod 7, so that the piston rod 7 is reciprocated between the low pressure chamber 12 in the forward or outer end of the cylindrical casing 1*a* and the high pressure valve chamber 37 formed in the inner end of the cylindrical casing 1a of the gun 1 as the piston rod 7 is reciprocated in the cylindrical casing 1*a*.

As shown in Figures 1, 3, 4 and 10, by drawing the hand grip 3 towards the inner end, gas is drawn in past the hand grip 3 and by the outside of the piston rod 7 and past the sleeve 19 of the outer end 12 of the piston rod 7, then past the O-ring 16 and past the tapered head on the outer end 12 of the piston rod 7 so that the gas is drawn into the low pressure chamber 13 in the forward end of the cylindrical casing 1*a*.

On reciprocating the piston rod 7 outwardly again to its forward position with the tapered outer end of the outer piston head 12 engaged in the tapered interior 9*a* of the buffer pad 9, gas is forced past the non-return valve 14 in the outer end 12 of the piston rod 7, so that gas under pressure passes along the longitudinal central bore 11 of the piston rod 7 to the inner piston head 31 on the inner end of the piston rod 7, and the gas passes by the check valve 39 in the high pressure valve chamber 37 in the inner piston head 31 and through the tapered end of the inner piston head 31 past the non-return valve 27 to the storage chamber 28 in the inner end of the cylindrical casing 1*a*.

On again reciprocating the piston rod 7 inwardly the check valve 39 in the high pressure valve chamber 37 in the inner piston head 31 is forced back around the inner end of the bore 11 of the piston rod 7 to seal off the said bore 11, and the inner piston head 31 advances with its tapered hole 36 towards the male part of the valve head 44 of the non-return valve 27 of the storage chamber 28 and in so doing, gas is forced past the non-return valve 27 and into the storage chamber 28, where on successive reciprocations of the piston rod 7 in the cylindrical casing 1*a* gas is built up under pressure in the storage chamber 28 for use as required in firing or expelling a shot from the gun 1.

What I do claim and desire to obtain by Letters Patent of the United States of America, is:

1. In an air gun including a gun barrel, apparatus for compressing and storing air comprising an elongated cylindrical casing situated alongside of and parallel to and fixed to the gun barrel, said casing having a closed outer end and an open inner end, a storage chamber for gas under pressure positioned in communication with said open end of said casing, a one-way valve within said storage chamber and adjacent the open end of said casing, a hollow piston rod positioned within said casing for axial reciprocation therein, said piston rod having an outer piston head adjacent said outer end of said casing and an inner piston head adjacent said inner end of said casing and also having a central section of enlarged diameter, means associated with each said piston head to provide a seal between said casing and each piston head, a longitudinal slot centrally located in said casing, a hand piece secured through said slot to said enlarged central section and operable on reciprocation thereof longitudinally of said casing to reciprocate said piston rod within said casing, air intake means associated with said outer piston head operable to allow air to enter into said casing between the outer end thereof and said outer piston head on rearward movement of said piston rod, and to prevent the reverse flow of air through said air intake means on forward movement of said piston rod, a low pressure one-way valve positioned in said outer piston head operable to allow air to pass from the space between the outer end of said casing and said outer piston head into the interior of said hollow piston rod on forward movement of said piston rod and to prevent passage of gas in the opposite direction through said low pressure one-way valve on rearward movement of said piston rod, a high pressure one-way valve positioned in

said inner piston head operable to allow gas to pass from the interior of said hollow piston rod into the space between said inner piston head and said storage chamber on forward movement of said piston rod and to prevent gas from passing in the opposite direction into the interior of said piston rod on rearward movement of said piston rod, said one-way valve within said storage chamber being operable to allow gas to pass from the space between said inner piston head and said storage chamber into said storage chamber on rearward movement of said piston rod and to prevent escape of gas from said storage chamber on forward movement of said piston rod.

2. The structure as claimed in claim 1 wherein said gas intake means comprises a sleeve mounted on said outer piston head having longitudinal ridges on the exterior surface thereof bearing on the interior of the cylindrical casing and forming passages therewith to permit gas to pass therealong, an annular groove in the outer piston head forward of said sleeve, and a low pressure O-ring loosely fit within said groove and having checked out portions on the forward side thereof extending radially thereacross.

3. The structure as claimed in claim 1 wherein said piston rod is of reduced diameter between said outer piston head and said central section and between said inner piston head and said central section and including oily wicks wound around on the reduced diameter portions of said piston rod to provide lubrication and reinforcement for said piston rod.

4. The structure as claimed in claim 1 wherein said inner piston head is formed of resilient material and includes an outer end in the shape of a cylindrical skirt adapted to fit snugly over the inner end of said piston rod, said skirt and piston rod being mechanically connected in assembly, the inner end of said inner piston head having a tapered bore flaring radially outwardly toward the one-way valve within said storage chamber, said inner piston head having an inner end portion less dense than the body portion thereof whereby a seal is formed between said inner end portion and the walls of said casing on inward movement of said piston rod which seal is due to radial outward flexing of said tapered bore as pressure is built up in the casing between said inner piston head and said storage chamber.

5. The structure as claimed in claim 1 wherein said inner piston head has an axial passage therethrough and said high pressure non-return valve comprises an axial cylindrical recess in the inner end of said hollow piston rod, a cylindrical member coaxial with said piston rod positioned within said recess and held therein by said inner piston head, said cylindrical member including a concave outer end in sealing relation to the interior of said hollow piston rod, a castellated inner end adjacent the passage through said inner piston head, and angularly spaced flat exterior surfaces extending between the ends thereof.

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