Sept. 21, 1948. S. W. MARSHALL, JR 2,449,560

GAS OPERATION OF FIREARMS ACTION SLIDES

Filed July 12, 1944

Fig. 1.

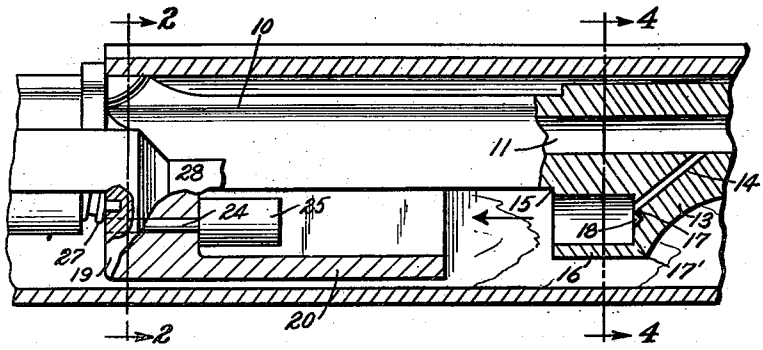



Fig. 2.

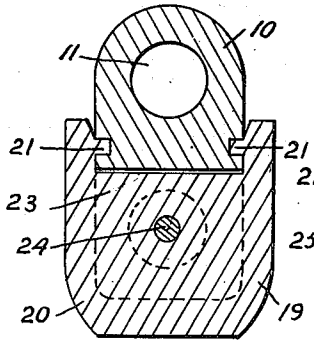



Fig. 3.

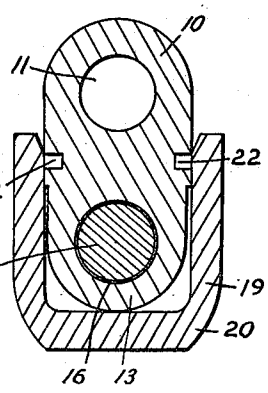



Fig. 4.

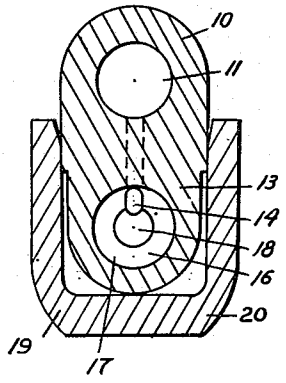
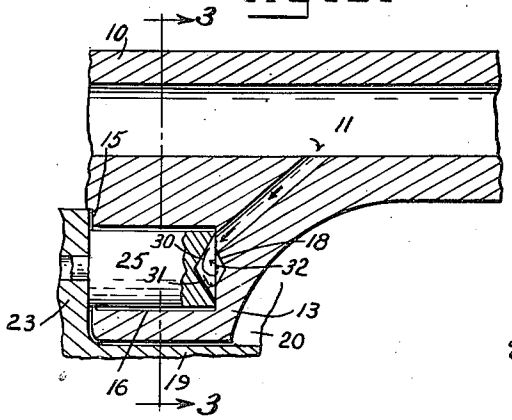



Fig. 5.

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2,449,560

## GAS OPERATION OF FIREARMS ACTION SLIDES

Samuel W. Marshall, Jr., United States Army

Application July 12, 1944, Serial No. 544,617

1 Claim. (Cl. 89—193)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

The invention relates to guns of the nature of the standard carbine, .30 caliber M1 heretofore largely used by the United States Army and particularly to details thereof disclosed in the following patents: 2,090,656, August 24, 1937; 2,308,257, January 12, 1943; 2,341,005, February 8, 1944, all to D. M. Williams. It is also adaptable to other utilizations of gases from gun barrels to operate gun actions.

It is an important aim to effect a simplification of the structure required, by a complete elimination of the special tooled form of the piston, elimination of the piston nut, and omission of counterboring, reaming and threading of the gas cylinder; making it possible to form the gas cylinder by a single simple bore, and to utilize a simple cylindrical bar as the piston, without a head enlargement, or special retaining means.

A paramount aim of the invention, contributing to the accomplishments above referred to, and others, is to produce new functions and results from the forces available from the gases, utilizing forces in the movement of the operating slide, which were not availed of in the prior construction, viz: effective impulse and reaction of masses of gas in rapid movement produced by the rearward discharge and explosive impact thereof through the gas port leading rearwardly from the barrel to the gas cylinder, supplementing the expansive force of the gas. Heretofore only simple pressure by gas confined in the gas cylinder was operative effectively on the piston, while in my present invention a conformation and arrangement of the piston is provided by which impact impulse and reaction are applied, in addition.

A further aim is to enable utilization of sustained expansive gas forces on the piston at the same time that initial high impulse and reaction of momentum values are obtained.

It is also an aim to avoid obstructive fouling of the gas port and cylinder by the gases utilized, especially by carbonization (that is, deposit of carbon on surfaces of the weapon), and to enable ready cleaning of hitherto inaccessible surfaces.

A still further purpose in view is the avoidance of requirement of highly accurate fit of the piston to the cylinder, yet obtaining effective driving of the piston.

It is also in view to avoid objectionable heating or fouling of the action or other parts of the

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weapon, and to avoid exposing the user of the arm to liability of burns or other discomfort incident to escape of gases through an opened cylinder, and other escape of gas in the weapon.

It is a further object to improve the venting of the gas cylinder to such extent as to effect automatic clearing of carbon therefrom.

A still further object is to adapt the piston to perform the double function of serving as a stop for forward movement of the operating slide at the same time that the benefits of attainment of the other objects of the invention above stated are had.

An important purpose of the invention is to enable the attainment of reaction functions to good advantage without requiring the preparation of special tool forms to produce peculiar structural or surface shapes as well as to avoid need for complicated or expensive production practice. Thus, it is sought to avoid requirement of complicated curved surfaces, or the polishing of the surfaces utilized for the impact reaction conversion of forces and motion of the moving gases into force and motion of the piston as required. On the contrary, by my invention a simple bore and countersink operation with common tools completes the cylinder and recess 18 hereinafter referred to, and the piston may be produced from rod stock by a cut-off, tenoning, and countersinking on its end, with ordinary simple tools usually available.

It is a further aim to reduce the amount of material required in the gun, to the end that it may be of less weight, as a whole.

An attainment of much worth is the formation of a reaction and impulse recess in the operating piston of the gas chamber in such manner that it will function with gases projected into the cylinder on a line diagonal to the axis of the cylinder, so that it does not become necessary to produce a curved passage or other form to admit the gases to the cylinder in a path parallel to the cylinder and barrel axes.

Additional objects, advantages and features of invention reside in the construction, arrangement and combination of parts involved in the embodiment of the invention, as will be apparent or understood from the following description and accompanying drawings, wherein:

Fig. 1 is a slightly enlarged fragmentary longitudinal section of a gun embodying the invention;

Fig. 2 is a cross section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3 of Fig. 1;

Fig. 4 is a cross section on the line 4—4 of Fig. 1;

Fig. 5 is a diagrammatic representation corresponding to Fig. 1, showing movements of gases.

Referring to the drawings, there is illustrated a portion of a firearm in which there is included a barrel 10, having a conventional bore 11 and chamber (not shown), as heretofore well known in a carbine largely produced and used. The barrel also has an enlargement 13 as heretofore, on its underside in which a cylinder or piston chamber has heretofore been formed from which an inclined passage or port 14 is extended forwardly through the lower inner face of the bore 11. This carbine barrel bore is of .30 caliber. The port in my device has been made .086-inch in diameter, and arranged at an angle of approximately 40° to the axis of the barrel. The enlargement 13 has a rear vertical planiform side 15, through which the cylinder 16 is bored, stopping short of the forward end or head 17' on the enlargement 13. In the prior device the cylinder was reamed to receive the somewhat enlarged head of a piston, and counter bored and threaded to receive a retainer collar or nut, through which the reduced rear end of the piston extended to engage the operating slide.

In the present instance, however, the cylinder 16 is simply rough bored, of uniform diameter throughout, to its closed head 17, so that the port 14 opens through the upper inner end face 17 of the cylinder head. This face 17 is planiform for the most part but a conical concentric recess 18 is formed therein, opposite elements of which intersect at an angle of 120 degrees. The diameter of the cylinder 16 has been made the same as that of the forward part of the prior cylinder, and is .40 of an inch. The action in this gun may remain unchanged or may be improved, utilizing the same operating or action slide 19 as heretofore, or an improved one of similar functions. This slide has a forward body part 20, U-shaped in cross section and having inwardly projected support flanges 21 on its sides at its rear part, which engage slidingly in longitudinal guide grooves 22 formed in lateral, external, vertical faces of the barrel. The rear end of the body 20 is formed with a transverse cross head and seat portion 23 of less height than the sides of the body 20, and considerably thickened longitudinally of the slide. It is bored longitudinally and coaxially with the cylinder 16, so as to receive with a driving fit the stem 24 of a piston 25, of slightly less diameter than the cylinder 16. This piston has been proportioned to set in the cylinder with a clearance of .0125-inch all around, and is of a length slightly greater than that of the cylinder, so that it serves as a stop to limit forward movement of the operating slide, by engaging the face 17 of the cylinder.

The forward end face of the piston is conically and concentrically recessed as at 26, the boundary of this recess being spaced slightly inward of the periphery of the piston, so as to afford an outer annular planiform end bearing and closure surface area sufficient for the motion-stopping function of the device. Opposite conic elements of the recess form an angle of about 122°, and the recess is approximately $\frac{3}{32}$ of an inch in depth longitudinally in the operative device, the opposed recess 18 closely approximating this form also, the angle of the conic section of the recess 18 being approximately 120 degrees. It is much smaller, however, than the recess in the piston,



having a diameter of approximately one-half that of the recess 26. The lower side of the port 14 intersects the upper part of this recess 18 more or less, according to the diameters of the port and recess. The two may be varied in size and form as found expedient, but the size of the port stated is preferably the maximum for the carbine mentioned.

The slide 19 is urged forward by an operating spring 27 set with its guide in a well in the rear side of a lateral enlargement 28 formed on the right side of the rear end of the slide body and from which a rectilinear bar 29 extends rearwardly at a higher level than the body 20, these being parts of the standard operating slide without change.

In the prior device the piston could operate on the slide over only approximately $\frac{5}{32}$ of an inch and the major rear portion of the enlargement 13 was required for the mounting of the retaining nut for the piston. The nut usually projected rearwardly of the enlargement 13 a distance, and the end of the piston in turn was required to extend rearwardly through and beyond the nut, so as to engage the seat 23.

In consequence of the changes which I have disclosed, a substantial portion of the material previously required for the mounting of the nut may be removed. Having regard for the time during which effective gas pressures are available in the gas cylinder to operate on the piston (which may include an extent of movement of the slide by such impulse greater than that through which the old style piston was effective on the operating slide), and also considering a time for partial relief of gas pressure in the cylinder which may be desirable, all material in the enlargement 13 to the rear of a limit established in accordance with the last named time factors may be removed. This will permit the location of the remaining part of the enlargement further toward the breech and consequent shortening of the operating slide, lightening the weapon.

In the use of this invention, the conventional ammunition is used, which produces a maximum pressure of about forty thousand pounds per square inch and a projectile speed of about 2000 feet per second at the muzzle. It is believed that nearly the maximum pressure is manifest at the time the bullet passes the port 14, although any drop in pressure which may occur, as heretofore demonstrated, does not prevent proper operation of the invention.

In the operation, the gun action functions as before, the slide 19 being at the forward limit of its movement when the trigger is operated. When the bullet passes the port 14, a blast of the high pressure gases is admitted through the port 14, which encounters the upper sloping side of the recess 26 at such angle as to be deflected downwardly as at 30 against the lower side of the recess, from which it is thrown forwardly.

In this latter movement a portion of the blast is directed against the lower side of the recess 18 from which it is thrown upward and then back again toward the piston. A small portion encounters at 31 the vertical end face 17 of the cylinder from which it reacts downward and backward against the piston again. The curved form of the conic surfaces against which the gases initially impinge tends to focus them toward the axis of the cylinder and to produce a symmetrical vortex 32 of gyration and reaction distinct from the choking action occurring with the flat-end

piston heretofore used, or others dependent on complete or nearly complete confinement of the gas admitted to the cylinder from the barrel.

As the piston moves under this impact, the center of the recess **26** moves rearward, approaching and passing an intersection with the axis of the port **14** and enlarging an annular zone around the focus of turbulence. The gases pass into this zone, escaping finally between the piston and cylinder, although with some confinement due to the turbulence of the gases while passing the rough surface of the cylinder bore, and the small clearance between cylinder and piston, which retard the escape flow materially.

At the same time that the movements described are occurring, the gases are becoming cooled after the initial action between the surfaces of piston and cylinder head, and are more dense, so that the movement thereof will represent greater mass and efficiency. In the latter part of the period of effective pressure through the port **14**, the above mentioned retardance of escape between the cylinder and piston will result in a degree of sustained pressure of gas against the piston, aiding in the movement of the operating slide, which will have been previously initiated. The relief of pressure past the piston will permit conversion of greater energy at the gas vortex, and limit unsymmetrical turbulence or mechanical hysteresis tending to impair the application of energy of momentum in the gas to propulsion of the piston.

As the center of the recess **26** passes rearwardly the intersection of the port axis with the recess face occurs at successively lower parts of the recess. It will be noted that the lower element of the conic surface is nearly at right angles to the port axis (the angle being approximately 80°) and that the surfaces on each side of this lower element are curved transversely upwardly and forwardly on each side of the path of the entrant gas, serving to return the dividing portions of the gas at each side toward the source and converting the motion and energy of the gas largely into rearward force acting against the piston and operating slide.

It should be understood that the principal operative effect or application of force to the operating slide by the device embodying this invention occurs almost instantaneously at and immediately after the instant of the impact of the initial blast from the port **14** against the piston, and extending over a period of time which may be $\frac{1}{750}$ second or less. There may be some additional benefit from gas pressure in the cylinder acting against the piston after the piston has moved backward an eighth of an inch which will serve to sustain motion of the slide already initiated by the reaction and impulse effect strongly manifest earlier. The pressure effect may continue in some degree until the forward face of the piston passes rearwardly of the axis of the port **14**.

Incident to the operation of the slide, whether by gas or manual force, the piston clears the cylinder completely. This occurs while the walls of the body **20** still extend forwardly beside and beneath the enlargement **13** so that the gases vented under pressure do not engage the surfaces of the stock, nor pass directly toward any interstices, openings, or joints in the enclosing stock elements or other enclosure. On the contrary, although cooled in part by escape between the cylinder and piston, gases escaping from the cylinder are baffled and further cooled



by impingement on the inner surfaces of the body **20**. Any noise made by the escaping gas will also be muffled by this body and by the enclosing stock portions. With the ammunition used, it is found that some carbon is deposited on surfaces within the body **20** of the operating slide which may be easily wiped off. These deposits do not become hard, and so, where they occur in the cylinder and on the piston, no stoppage occurs, even if the surfaces are not promptly cleaned manually, since the rush of gases occurring on repeated shots will remove excessive deposits.

As shown in the prior carbine referred to, and manifest with my invention also, after clearance of the piston from the cylinder, the slide **19** continues its movement to a total distance from initial or extreme forward position about so that the piston lies rearward of the enlargement **13**, before the spring **27** returns it to initial position. As the slide is removable from the action assembly by a manipulation of the parts in unique sequence, without the use of tools, it is a simple matter to remove the operating slide to completely clear the space rearward of the cylinder, exposing the latter for clearing, and the piston is thereby also removed and made readily accessible through the open upper side of the body **20**. The cylinder and piston may thus be both readily cleaned without special disassembly or application of tools for effecting access thereto.

It may be noted that the form and size of the parts disclosed and the size, form and arrangement of the port **14** and recesses **18** and **26** have been found effective, and that the same details as disclosed except with the recesses **18** and **26**, omitted but with simple planiform surfaces provided on the piston head and cylinder head, failed to operate effectively.

It should be appreciated that by the venting of gas without the symmetrical vortex **32** tendency of unsymmetrical turbulence to interfere with the movement of gas in this vortex is reduced and the general impact effect improved. As a consequence applicant is able to obtain the same functioning of the action slide as heretofore without the snug piston fit and numerous parts which were required, avoiding requirement of reaming finishing, and fitting operations heretofore involved.

The clearance around the piston, in addition to its functional effect in relieving pressure in the cylinder, also obviates the need for lubrication heretofore necessary in the prior piston, and avoids liability of sticking of the piston due to accumulation of deposits from gases discharged from the gun bore, as above explained, since expansion of the piston is not sufficient to materially decrease the clearance between the piston and cylinder wall.

While I have disclosed my invention with great particularity, in the best form known to me, it will nevertheless be understood that this is purely exemplary, and that various changes in construction, arrangement and combination of parts, substitution of materials or equivalents, mechanical or otherwise, may be made without departing from the spirit of the invention as set forth in the appended claim, wherein:

I claim:

In a gun of the character described, a barrel having a bore terminating at its rear end in a cartridge chamber, a gas cylinder fixed with said barrel and parallel thereto adjacent said chamber, said cylinder having its rear end open, an

operating slide guided for movement along said barrel in a rectilinear path parallel with said bore, said path having a greater length than said cylinder, a piston fixed to said slide in a position coaxial with said cylinder and adapted to enter said cylinder during the final portion of the forward travel of said slide, said piston having a loose gas-free fit in said cylinder, there being a first conical recess in the forward face of said piston and having a base diameter slightly less than the diameter of said piston whereby to leave an abutment ring on said face, there being a second conical recess in the forward end wall of said cylinder and having a smaller base diameter than said first recess, there being a rectilinear passageway in a plane containing the axes of said bore and cylinder and extending from the bore of said barrel, rearwardly at an acute angle to said bore and opening through the head of said cylinder outside the base circumference of said second recess, the apex angles of said recesses being of the order of 120°.

SAMUEL W. MARSHALL, JR.



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