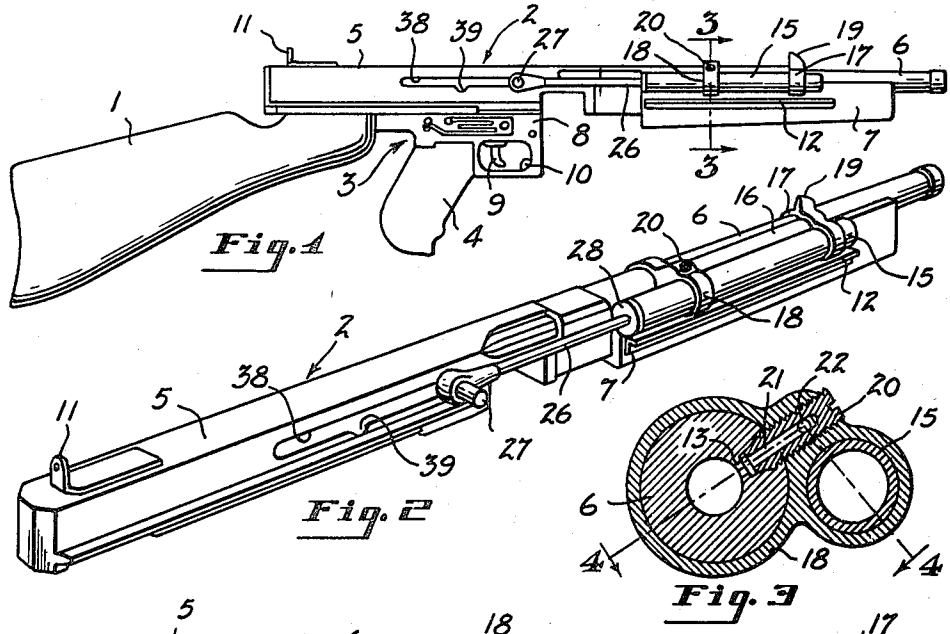
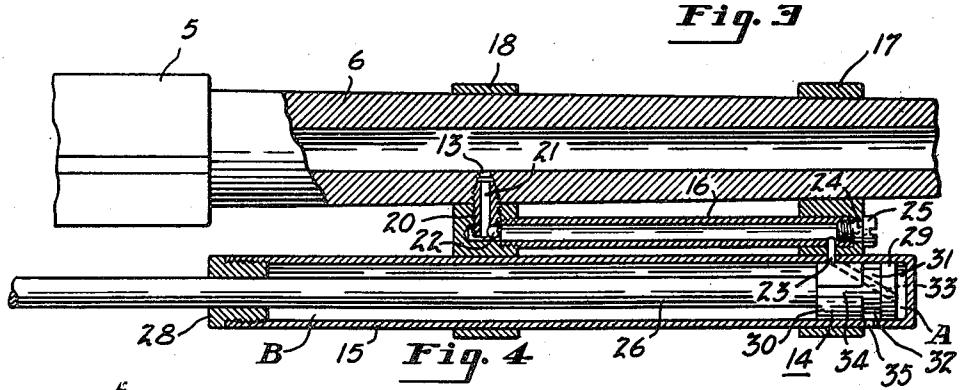
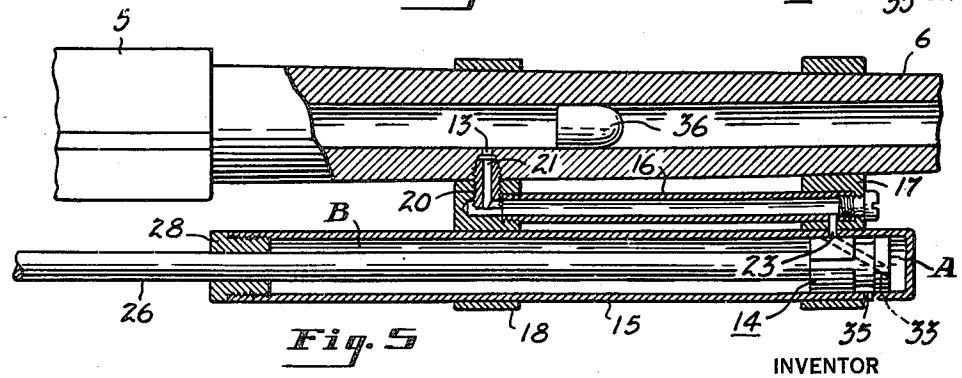
Dec. 23, 1958 R. MARSH 2,865,256

COMPENSATING DEVICE FOR FIREARMS

Filed Oct. 13, 1954 3 Sheets-Sheet 1







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ATTORNEYS

Dec. 23, 1958 R. MARSH 2,865,256

COMPENSATING DEVICE FOR FIREARMS

Filed Oct. 13, 1954 3 Sheets-Sheet 2

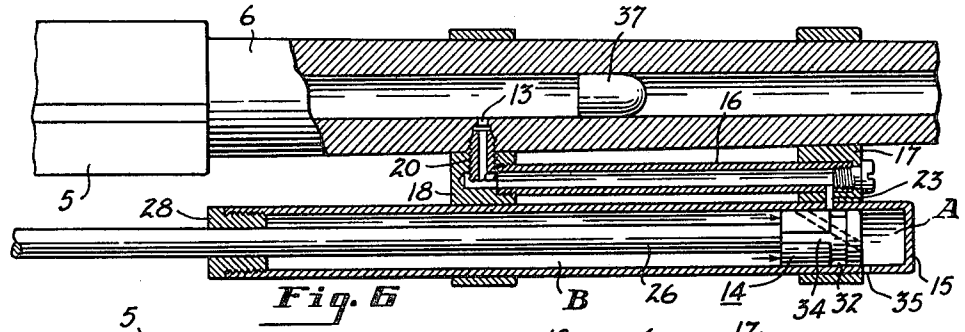


Fig. 6

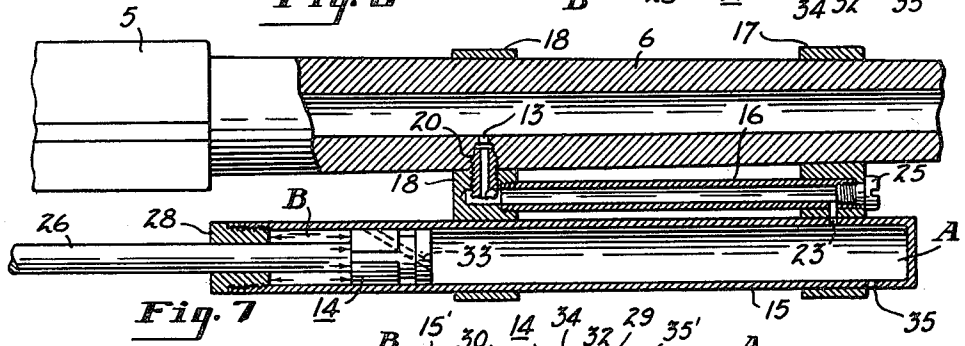


Fig. 7

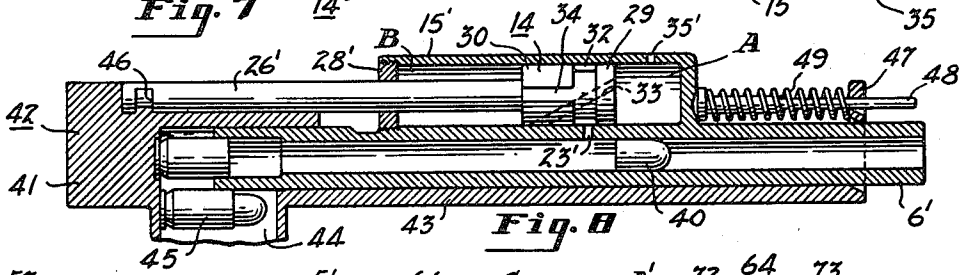


Fig. 8

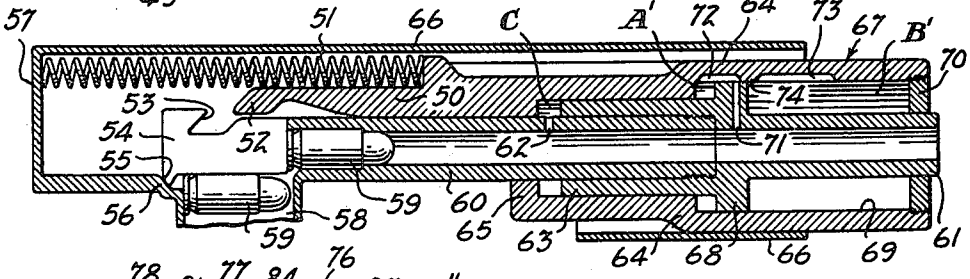


Fig. 9

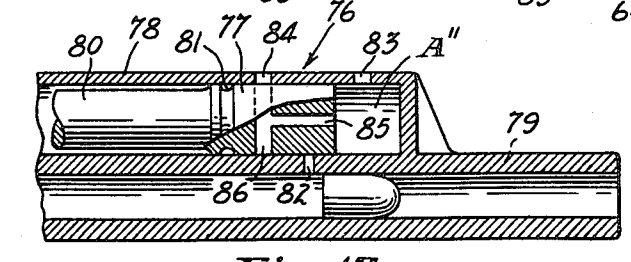


Fig. 10

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COMPENSATING DEVICE FOR FIREARMS

Filed Oct. 13, 1954 3 Sheets-Sheet 3

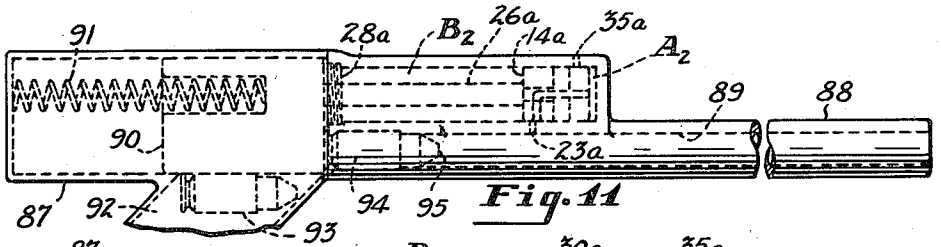


Fig. 11

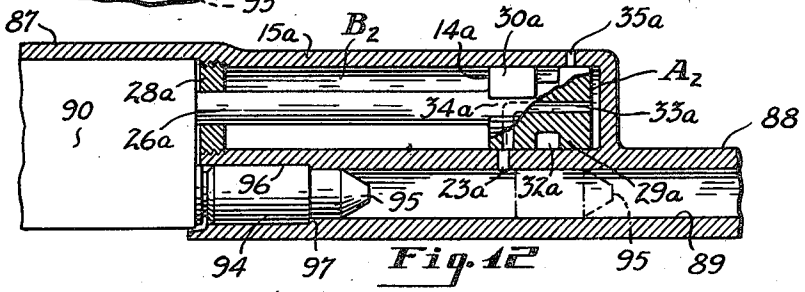


Fig. 12

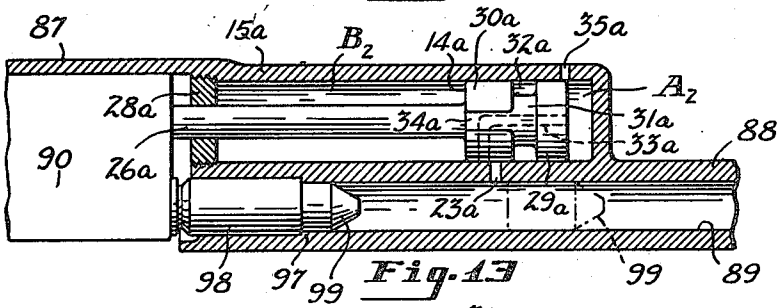


Fig. 13

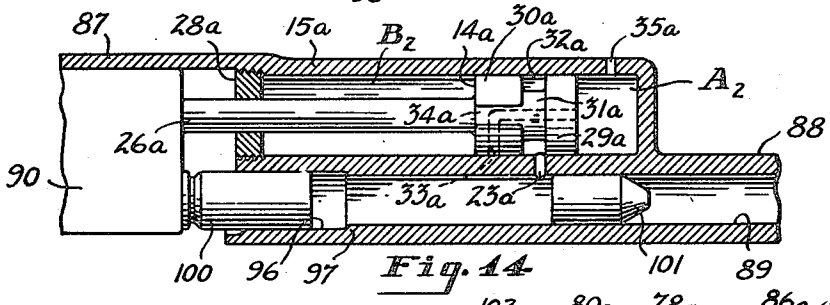


Fig. 14

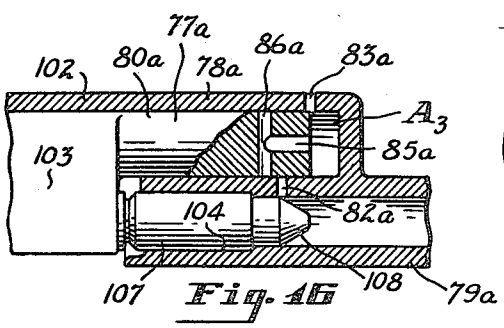


Fig. 16

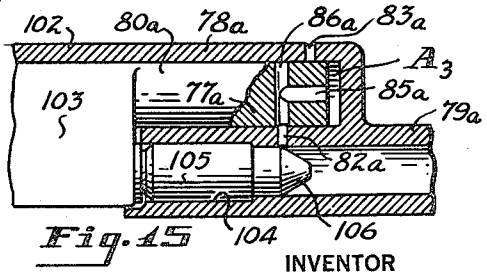


Fig. 15

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United States Patent Office 2,865,256
Patented Dec. 23, 1958

2,865,256

COMPENSATING DEVICE FOR FIREARMS

Roger Marsh, Hudson, Ohio, assignor to Weapons, Inc., Hudson, Ohio, a corporation of Ohio

Application October 13, 1954, Serial No. 461,999

2 Claims. (Cl. 89—191)

This application is a continuation-in-part of my co-pending application Serial No. 390,915, filed November 9, 1953, now abandoned.

The present invention relates to an actuating-power-variation compensating device for self-actuating firearms such as semi-automatic rifles, machine guns, machine cannons, submachine guns, automatic pistols, and/or the like.

In a self-actuating firearm the power to perform one or more actions in the functioning cycle (for example, feeding, obturating or locking, firing, extracting, ejecting, and/or cocking) is supplied by the combustion or explosion of the propellant in a round of ammunition or cartridge. Conventional self-actuating firearms do not always perform properly when the power or energy released by the combustion of the propellant in a round is deficient or excessive, when the weight of the projectile or bullet is abnormal, when the cartridge case is of improper length and at other times, since the "actuating power" or the portion of the energy released by combustion of the propellant available to perform one or more of the actions in the functioning cycle may be excessive or insufficient to assure proper operation. The actuating-power-variation compensating device of the present invention compensates for differences in the "actuating power" or "actuating energy" of the rounds of ammunition so as to assure proper operation of an automatic or semi-automatic self-actuating firearm without malfunction when the explosive power or weight of the cartridges is non-uniform and at other times. This permits the use of high or low power ammunition when desired without the necessity of manual adjustment during firing and reduces malfunctions due to faulty ammunition.

Self-actuating firearms usually include a barrel, means for feeding individual rounds of ammunition to the barrel, and actuating mechanism responsive to the "actuating power" and movable with respect to the barrel or some other part of the gun during travel of a bullet in the barrel a distance and at a velocity substantially proportional to the magnitude of the "actuating power" to perform one or more of the actions in the functioning cycle. This power is supplied by the expanding propellant gases immediately after ignition and is harnessed directly through appropriate sliding or moving members to do its work or indirectly through compression of a spring or through other storage means to perform its work at a later time. The actuating mechanism may be operated, for example, by blowing back the breech block directly, utilizing the recoil of the gun, or leading off a small portion of the powder gases. The term "self-actuating firearm" therefore includes practically all fully automatic and semi-automatic guns or cannons where one or more of the functions which must be performed in the operation of the fire arm is performed automatically by transmitting energy from the fired charge to the mechanism of the gun. The term includes anti-aircraft

cannons wherein all the operations except loading and firing are performed automatically and also includes blow-forward firearms wherein the stock and all the framework of the fun are firmly attached to the breech block and the barrel is allowed to move forward after firing. The term also is broad enough to encompass various gas-operated firearms with low recoil and may include automatic firearms which are recoilless. However, most self-actuating firearms include means to close the breech end of the barrel or to resist rearward movement of the powder gases and therefore have substantial recoil.

The present invention provides means to vary the movement and the velocity of the moving or recoiling parts of a firearm and may be incorporated into various types of self-actuating firearms employing actuating mechanism as described above to assure proper functioning. The compensating device of the present invention may be used, for example, on low-powered self-actuating firearms wherein the breech block is allowed to move back with respect to the barrel and is blown back directly by the combustion gases. Such low-powered firearms are of the inertia or blowback type wherein the rearward thrust of the propellant gases is resisted by a massive bolt and sometimes to a lesser extent by springs and wherein the bolt is given a relatively low velocity by the thrust of the gases and transforms some or all of its kinetic energy into potential energy of the bolt return spring, if such is present, during the rearward movement. Some guns, such as the so-called "automatic" pistols, are of the direct or straight blowback type. The compensating device may be used on these guns and also on guns of the delayed inertia or retarder blowback type wherein the blowback member is retarded not only by the weight of the breech but also by the use of a mechanical disadvantage or by an auxiliary device, such as a link or a wedge. The compensating device may be used, for example, on a Thompson M 1928 A1 submachine gun which has a cam causing downward movement of a sliding wedge so as to retard rearward movement of the breech block.

Where long barrels, high bullet weights, and high muzzle velocities are involved, the blowback principle is not always satisfactory and it is often found preferable to lock the breech block of the gun to the barrel at least during the initial recoil of the gun. The compensating device of the present invention may be used on both recoil-operated and gas-operated guns of this type and on guns having inertia-locked breech mechanisms. The compensating device may be used, for example, on a firearm of the "short-recoil" type wherein the barrel moves only a short distance and the breech moves through the rest of its travel from the momentum imparted to it by this motion and may be used on a firearm of the "long-recoil" type wherein the barrel moves all the way to the rear along with the breech block and then leaves the breech block in the rearward position while the barrel goes forward.

Guns of this type are called locked-breech firearms and are operated by utilizing the recoil of the gun, by leading off a small portion of the propellant gases, or by other means. The compensating device of the present invention may be applied to any locked-breech recoil-operated gun in which the breech-block is mechanically locked to the barrel to minimize relative displacement of the breech face and the barrel at the moment of firing and in which the barrel and bolt are permitted to recoil locked together for a certain distance under pressure of the propellant gases, this movement being sufficien to perform or to deliver into the mechanical system of the gun energy to perform various functions of the operating cycle, such as unlocking, extraction, etc.

The compensating device may also be used on locked-breech gas-operated firearms in which the bolt or breech block is mechanically locked to the barrel to minimize relative displacement of the breech face and the barrel at the moment of firing, but in which the propellant gases are tapped off or conducted from the bore through an aperture or passage leading from the bore to an appropriate mechanical system where they are used to supply energy to perform various functions of the operating cycle. Guns of this type, such as the Garand rifle and the Browning automatic rifle, are used extensively and do away with the necessity of mounting the barrel so that it can slide.

In most of the above types of self-actuating firearms the initial movement of the actuating mechanism is in a direction opposed to that of the movement of the projectile. However, the compensating device of the present invention may obviously be used on a self-actuating gun of the blowforward type in which the initial movement of the actuating mechanism is in the same direction as that of the movement of the projectile. In such a gun the barrel is mounted to move forwardly with respect to the framework of the gun and the forward movement of the projectile through the barrel is resisted by friction between the projectile and the interior surfaces of the barrel whereby some of the power of the expanding propellant gases is available to move the barrel forwardly away from a standing breech and to compress an appropriate return spring. In some blowforward guns it is necessary to obtain a portion of the actuating power from some intermediate agent other than barrel-bullet friction, for example, by tapping off gases from the barrel as in a forwardly-moving-barrel gas-operated weapon. It should be noted that there is little difference mechanically between a blowforward gun and a blowback gun wherein the expanding propellant gases are available to move the breech rearwardly away from the barrel since in each gun the breech block and the actuating mechanism move rearwardly with respect to the barrel. Therefore, the same type of compensating device may often be used on both a blowforward and a blowback gun.

The compensating device of the present invention may be applied to the various firearms described above, to various other gas-operated firearms, and also to some firearms which are not classified as gas-operated, locked-breech recoil-operated, locked-breech gas-operated, blowback, or blowforward guns. However, almost all automatic and semi-automatic guns in general use today are one of these five types or a combination of two or more of these types and may be modified in one way or another to utilize the compensating device for the present invention. The compensating device may be used, for example, on an unlocked-breech gas-operated firearm, such as a gas-operated blowforward gun or various other gas-operated guns.

It will be understood that the compensating device may also be used on a self-actuating firearm adapted to fire self-consuming-case cartridges and other types of ammunition.

The compensating device of the present invention permits the use of ammunition stronger or weaker than that for which the firearm was developed without malfunctions and eliminates the necessity of making manual adjustments required because of dirt, fouling, wear on parts, changes in bullet weight, changes in propellant weight, changes in the combustion rate, and/or other variables to compensate for variation in the "actuating power."

The compensating device may also permit changes in the initial position of the main actuating mechanism of the gun before firing due to changes in the shape or in the length of the cartridge case or due to some obstruction which prevents the cartridge case or the bolt from going fully home during loading of the gun. If the full forward movement of the main actuating mechanism with

respect to the barrel is prevented because of an obstruction on the cartridge case or for some other reason, less "actuating power" is required to obtain proper functioning of the gun, and it is desirable to modify the operation of said actuating mechanism by means of an auxiliary compensating device particularly where such forward movement is prevented by an excessively long cartridge case which may be overly powerful.

For the purposes of the present invention the term "actuating power" or "actuating energy" has been employed to describe the portion of the power or energy from each round of ammunition used to perform various functions in the operating cycle such as loading, obturating, extraction, cocking, firing, etc. Thus in a blowback gun the "actuating power" is the pressure of the powder gases thrusting backward against the bolt. In a blowforward gun the "actuating power" is usually the pressure of the powder gases acting through the projectile to drag the barrel forward. In a locked-breech recoil-operated gun, the "actuating power" is the pressure of the powder gases acting to drive rearwardly the barrel and breech block, and in a locked-breech gas-operated gun, the "actuating power" is the pressure of the powder gases tapped off to drive a piston or other operating means.

The function of the actuating-power-variation compensating device is to modify the "actuating power" automatically to prevent malfunction without requiring manual adjustments to be made by the operator of the gun. The device may have a booster function, a buffer function, or both.

According to the present invention the "actuating power" of a self-actuating firearm is modified by means of either a reversible or double-acting motor or a single-acting motor which is connected to the recoiling parts of the firearm. The motor is automatically actuated by a control mechanism in a direction to increase movement of the recoiling parts and thereby to increase the actuating power when said power is inadequate to assure adequate functioning of the gun and may also be automatically actuated in the opposite direction when said power is excessive. Such control mechanism may be responsive to the length of the cartridge case, to the initial position of the recoiling parts of the main actuating mechanism, to the rate of movement of such parts, or to the amount of movement of such parts after the projectile has traveled a predetermined distance. Said motor is preferably substantially ineffective over a considerable range when the actuating power is within a normal range so as to permit functioning of the gun without modification. It will be noted that, while the compensating device may be most advantageously incorporated into the original design of a self-actuating firearm, it may also be employed to advantage on existing arms. Whether the compensating device is employed as an accessory or is incorporated into the original design of the gun, it is usually preferable to utilize the double-acting motor as an auxiliary mechanism and not as the main actuating means for operating the loading mechanism or for performing another function in the operating cycle.

The reversible motor employed in the present invention is preferably operated pneumatically instead of hydraulically or electrically and ordinarily takes the form of a reciprocating-piston double-acting fluid motor utilizing gas under pressure as the motive fluid. The control mechanism for the fluid motor preferably comprises a valve which is connected to the moving or recoiling parts of the gun for movement therewith. Said valve is preferably incorporated in the cylinder or the double-acting piston of the motor and moves in recoil with the cylinder or the piston, respectively. Of course, it is to be understood that a single-acting motor may be employed where compensation in one direction only is satisfactory. The source of motive fluid for the motor is preferably the barrel of the gun.

Since the position of the fluid control valve is an indi-

cation of the position of the movable parts of the main actuating mechanism of the gun, the valve may control the motor in accordance with the initial position of such parts before firing and/or the position of such parts when the projectile has moved a predetermined distance. The piston or cylinder of the motor preferably serves as the valve and controls the flow of gases to the motor from a gas intake port at the bore of the barrel. The distance traveled by the recoiling parts of the gun and by the valve during the passage of the projectile down the bore to a position just beyond the gas port is a measure of the recoil velocity of the actuating mechanism of the gun and of the actuating power provided that the port is spaced a substantial distance from the breech end of the barrel.

The valve may therefore control the motor in accordance with the actuating power of each round of ammunition. Even where the gas port is located a very small distance from the initial position of the bullet or projectile before firing (for example, less than three times the diameter of the projectile), the piston valve will compensate for changes in the amount of actuating power required for proper functioning of the main actuating mechanism due to changes in the initial position of such mechanism relative to the barrel. Where such changes in the initial position are due to changes in the length of the cartridge case, the compensating device makes up for changes in the strength of the powder charge which may accompany such changes in length.

Where a normal round of ammunition is employed and the recoiling parts of the gun are in a normal position before firing, the recoil of the valve after firing is within a normal range and communication between the interior of the barrel and the motor is preferably cut off by said valve when the projectile passes the gas port so that the motor is ineffective. Where the recoiling parts are in a normal position before firing and the movement or the velocity of the valve after firing and during the passage of a projectile through the barrel beyond the gas port is inadequate and below said normal range, the actuating power is inadequate to assure proper functioning and the valve establishes communication between the barrel and one end of the double-acting piston so that the motor acts as a booster in a direction to increase the actuating power and increase the movement and the velocity of the recoiling parts. When the movement of the valve is more than adequate and beyond said normal range, the valve connects the barrel and the other end of said piston so that said motor acts as a buffer in the other direction to decrease the actuating power and retard movement of the recoiling parts. Movement of the valve beyond said normal range due to changes in the initial position of the main actuating mechanism before firing of the gun likewise compensates for the increase or decrease in the actuating power required for proper functioning of the actuating mechanism.

An object of the present invention is to provide mechanism which automatically compensates for variation in the actuating power of ammunition used in self-actuating firearms, such as semi-automatic and automatic guns and cannons, so as to ensure proper functioning without manual adjustment during firing.

A further object of the invention is to provide a simple and inexpensive compensating device which may be used as an auxiliary on existing firearms.

Another object of the present invention is to provide an auxiliary motor means for self-actuating firearms which compensates for variation in the actuating power available from the ammunition due to changes in the length or size of the ammunition.

Other uses, objects, and advantages will become apparent to those skilled in the art from the following description.

Reference should be had to the accompanying drawings in which:

Figure 1 is a side view of a standard Thompson M1 or M1A1 submachine gun converted to incorporate the compensating device of the present invention;

Figure 2 is a perspective view of the Thompson gun shown in Fig. 1 with the butt stock, rear grip, and frame group removed;

Figure 3 is a sectional view of the compensating device taken substantially on the line indicated at 3—3 in Fig. 1 with parts of the gun removed;

Figure 4 is a fragmentary longitudinal sectional view taken substantially on the line indicated at 4—4 in Fig. 3 indicating the position of the compensating piston before firing;

Figure 5 is a view similar to Fig. 4 showing the position of the compensating piston after firing an insufficiently powerful cartridge;

Figure 6 is a view similar to Figs. 4 and 5 showing the position of the compensating piston after firing an excessively powerful cartridge;

Figure 7 is a view similar to Figs. 4 to 6 showing the position of the compensating piston in full recoil;

Figure 8 is a diagrammatic sectional view of a blow-forward type gun incorporating the compensating device of the present invention showing the position of the compensating piston after firing an excessively powerful cartridge;

Figure 9 is a diagrammatic sectional view of a locked-breech gas-operated gun incorporating a modified form of compensating device showing the position of the compensating piston before firing;

Figure 10 is a fragmentary diagrammatic sectional view of another modified form of compensating device showing the position of the compensating piston after ciently powerful cartridge;

Figure 11 is a diagrammatic side elevational view on a reduced scale of a blowback type firearm incorporating one form of compensating device of the present invention, the parts being shown in their positions just before firing a round having a short cartridge case;

Figure 12 is a fragmentary vertical sectional view on a larger scale of the firearm shown in Fig. 11 showing in solid lines the position of the bullet in the short cartridge case just before firing and in dotted lines its position just after firing;

Figure 13 is a view similar to Fig. 12 and on the same scale showing the parts of the blowback gun of Fig. 11 in their positions just before firing a round having a normal size cartridge case, the position of the bullet just after firing being shown in dotted lines;

Figure 14 is a view similar to Fig. 12 and on the same scale showing the parts of the blowback gun in their positions just after firing, such parts being displaced rearwardly an excessive amount with respect to the barrel due to an overly powerful charge and/or improper positioning of the parts just before firing due to a long cartridge case, an obstruction preventing forward movement of the bolt or cartridge, or a similar cause;

Figure 15 is a fragmentary diagrammatic longitudinal sectional view showing a modified blowback firearm incorporating a compensating device which corrects for changes in the length of the cartridge case and the like, the parts being shown in their positions before firing a round having a short cartridge case; and

Figure 16 is a view similar to Fig. 15 and on the same scale showing the firearm of Fig. 15 with its parts in their positions just before firing a round having a normal size cartridge case.

Although the compensating device of the present invention may readily be incorporated into the original design of any self-actuating firearm of the blowback type (for example, a so-called "automatic" pistol), it has been found convenient to illustrate the compensating device of the present invention as an accessory on an existing type of gun, such as a standard late model submachine gun, whose operation is well known to those skilled in the art. From a description of the operation

of such a gun, it should be apparent how the compensating device may be applied to other types of self-actuating firearms.

Referring more particularly to the drawings in which like parts are identified with the same numerals in the several views, Figures 1 to 7, inclusive, illustrate the addition of a compensating device to a standard Thompson M1 or M1A1 submachine gun with the sling removed. A gun of this type should readily be recognizable since it was a principal type of submachine gun used by the U. S. Army in World War II. The gun illustrated has conventional parts including a wooden butt stock 1, a receiver group 2 attached to the upper end of the butt stock, a frame group 3 attached to the bottom of the receiver group, and a rear grip or handgrip 4 extending downwardly from the frame group.

The receiver group comprises a receiver 5 which forms the skeleton of the gun and into which a barrel 6 is screwed. The barrel holds in place a fore grip mount to which is secured a longitudinally elongated wooden foregrip 7. The receiver 5 immediately to the rear of the barrel is provided with an opening for box magazines and with a bolt well. Beyond the magazine opening is a uniform enlarged cavity which contains the body of a bolt, with recoiling space for the same. Inside the receiver are located conventional mechanisms including, in addition to the bolt, a firing pin, a buffer, a recoil spring, an extractor, and an ejector as is well understood in the art.

The frame group comprises a frame 8 which houses the entire trigger mechanism including the trigger 9, furnishes a seat for the rear grip 4, furnishes an attachment for the box magazine, and contains a magazine catch 10 to hold the latter in place. The rear projection of the frame 8 is attached to the butt stock. The frame group consists of a pivot plate, trigger, trip, disconnector, sear lever, sear, trigger spring, disconnector spring, sear spring, and sear lever spring and is the same as in the Thompson Model 1928 A1 guns.

Sights are provided for use in connection with the butt stock to fire the gun from the shoulder. A rear sight 11 is riveted to the top of the receiver for this purpose.

In order to convert the submachine gun for use with the compensating device of the present invention, it has been found desirable to replace the original bolt handle, to remove the conventional front sight from the forward end of the barrel, and to replace this sight with a new sight. The horizontal foregrip of the gun has also been modified to receive the compensating device. The tongue portion of the foregrip mount adjacent the barrel has been removed to provide an unobstructed annulus between the barrel and the foregrip for slidingly receiving the compensating device, and the foregrip has been partially cut away to provide room for this device.

If desired, metal guards may be placed on opposite sides of the wooden foregrip 7 along the cut away portions thereof. As herein shown a longitudinal metal angle beam or guard 12 is attached to the horizontal foregrip, said foregrip being partially cut away at its rearward end flush with the top surface of the angle beam 12.

The standard submachine gun may be easily altered as pointed out above so that the compensating device may be positioned on the gun. The final alteration comprises machining a tapered counterbore in the upstream end of the barrel so as to form a gas port 13 and a threaded connection for holding the compensating device on the barrel. Except for the minor alteration described, the submachine gun shown in Figs. 1 to 3 with the compensating device removed is the same as a standard Thompson gun and has conventional rifling. Therefore a further description of the conventional or standard parts of such a gun is believed unnecessary.

The compensating device of the present invention includes a double-acting compensating piston 14, a gas cylinder 15 in which the piston reciprocates, and a cylindrical conduit 16 having an axis parallel to the axes of the barrel 6 and the cylinder 15, said conduit being provided because of the long action stroke of the Thompson gun and comparatively short barrel. The conduit and the cylinder are supported on the barrel by front and rear double supporting collars 17 and 18 which fit around the cylinder and the conduit, which may be slid over the barrel, and which are adapted to surround and to engage the entire periphery of the barrel when positioned as illustrated in Figs. 1 to 7. The front collar 17 has a portion forming a front sight 19 which replaces the original front sight, and the collar is secured to the gas cylinder 15 by suitable means such as a weld.

The rear collar 18 is threaded to receive a hollow gas tap-off screw 20 which extends into the tapered counterbore of the barrel to prevent movement of the compensating device with respect to the barrel. The screw 20 is provided with a central passage 21 which communicates with the bore of the barrel 6 through the gas port 13, the nose of said screw fitting tightly against and sealingly engaging the tapered counterbore after assembly so as to prevent leakage of gas around the screw. A port 22 is formed in the screw 20 adjacent the upper end of the passage 21 to provide communication between said passage and the open rear end of the conduit 16.

In order to provide communication between the forward end of the conduit 16 and the interior of the gas cylinder 15, a gas port 23 is formed by drilling through the walls of the gas cylinder, the front collar, and the conduit. Propellant gases in the barrel are therefore permitted to pass from the barrel through the gas port 13, the passage 21, the port 22, the conduit 16, and the port 23 to the gas cylinder 15 to actuate the compensating piston 14, the port 23 being displaced from the port 13 because of the long stroke required for the piston 14 and the relative shortness of the barrel 6.

In order to prevent the collars 17 and 18 from moving apart due to the pressure of the powder gases, the conduit 16 is fixed to both the collars. The forward end of this conduit is internally threaded forwardly of the port 23 to receive a screw 24 that has a slotted head 25 for engagement with the front surface of the collar 17. The rear collar 18 is internally threaded forwardly of the screw 20 to receive the internally threaded rear end of the conduit 16.

Since the cylinder 15 is fixed to the collar 17 and fits tightly in the collar 18 and since the collars 17 and 18 are fixed to each other by conduit 16, the screw is effective to prevent movement of the gas cylinder 15 with respect to the barrel 6.

The compensating device is detachably connected to the bolt and other recoiling parts of the standard Thompson gun by means of a piston rod 26 and a special elongated bolt handle 27 which replaces the original handle and is connected to the bolt in the usual manner. The handle 27 travels back and forth during automatic firing in a longitudinally elongated slot 38 formed in the right side of the receiver, the handle cooperating with a disassembly notch 39 in said slot in the conventional way when the gun is disassembled. The piston rod 26 is centered in the gas cylinder 15 and has a sliding fit in an externally threaded gas cylinder plug 28 which is screwed into the rear end of the gas cylinder, said rod being connected to the piston for reciprocation therewith so that the piston and the bolt reciprocate in unison. The rod 26 is of such diameter as to move freely within the plug 28 without permitting excessive escape of gases.

It should be apparent from the above description that the gas cylinder 15 and the compensating piston 14 form a double-acting fluid motor that receives motive fluid from the barrel and that is adapted to modify movement of the bolt and other recoiling parts. The action of the motor on the actuating mechanism of the gun may be controlled by placing a suitable motor control means

such as a valve between the source of motive fluid and the motor. According to the present invention this control means is responsive to the "actuating power" produced by firing each round of ammunition and is movable a distance and at a velocity substantially proportional to this power after firing and before the projectile leaves the barrel. It has been found most convenient to incorporate the motor control valve in the compensating piston **14** since this piston moves the same distance and at the same velocity as the actuating mechanism of the gun.

As herein shown the compensating piston **14** functions both as the double-faced piston of a double-acting fluid motor and as a piston-type valve for controlling the flow of motive fluid through the port **23** to the motor. One type of piston valve which may be used is illustrated in Figs. 4 to 8. This valve has front and rear cylindrical port-closing portions **29** and **30** which fit within and sealingly engage the inner cylindrical surface of the gas cylinder **15** and has an intermediate cylindrical portion **31**, an annular groove **32** being formed between the front and rear portions. An internal passage **33** is formed in the piston valve **14** and extends from the rear portion **30** to the front face of the piston and for conveying the powder gases from the port **23** to a booster chamber A at the forward end of the gas cylinder as shown in Figs. 4 and 5. An external longitudinal groove or passage **34** extends from the annular groove **32** to the rear face of the piston so as to establish communication between the port **23** and a buffer chamber B at the rear end of the gas cylinder when the "actuating power" of a round is excessive as shown in Figs. 6 and 8.

The gas cylinder **15** supported on the Thompson submachine gun communicates with the gas ports **13** and **23** and with the bore of the barrel **6** as pointed out above and also communicates with atmosphere through one or more vent ports or apertures **35** formed in the wall of the cylinder adjacent the front face of the collar **17**. However, it should be noted that the piston valve cuts off communication between the port **23** and the port **35** whenever a portion of the valve is forwardly of the port **23**.

After a round of ammunition or a cartridge is fired in the barrel **6**, three possible alternatives present themselves when firing cartridges of the same size. The cartridge may supply insufficient power to properly operate the actuating mechanism of the gun, may supply the right amount of power, or may be overly powerful.

Figure 4 illustrates the position of the compensating piston **14** before firing. After firing a round that is insufficiently powerful or below normal whereby the movement of the actuating mechanism is less than that required to assure adequate functioning, the compensating piston is actuated by the high pressure propellant gases in a direction to increase the recoiling movement of the bolt. Figure 5 illustrates the position of the compensating piston **14** after firing such a round and while a bullet **36** from said round is still in the barrel **6**. In this position gases from the barrel pass through the ports **13** and **23** and the internal passage **33** to the booster chamber A so that pressure is applied only to the front face of the compensating piston.

After firing an excessively powerful cartridge and before the projectile leaves the barrel, the compensating piston is actuated by the expanding propellant gases in a direction to decrease the movement of the bolt and other recoiling parts. As shown in Fig. 6, an excessively powerful cartridge containing a bullet **37** causes movement of the compensating piston before the bullet leaves the barrel to a postion where propellant gases enter the buffer chamber B through the ports **13** and **23** and the grooves **32** and **34**, the front portion **29** of the piston valve cutting off communication between the barrel and the booster chamber A at this time.

After firing a round whose "actuating power" is within a normal range, the compensating piston is rendered substantially ineffective preferably by cutting off the flow of power gas from the barrel to the piston so as to permit functioning of the firearm to proceed without modification. When the compensating piston moves in recoil after firing a normal round to a position for example substantially midway between the positions shown in Figs. 5 and 6, the port **23** is completely blocked off so that the piston **14** does not substantially affect the movement of the bolt or other recoiling parts of the submachine gun.

Figs. 5 and 6 show the positions of the compensating piston during the initial recoil of the bolt and the bolt handle **27** before the bullet has left the gun. Figure 7 shows the position of the compensating piston as the bolt handle approaches its rearmost position in full recoil. While there may be a small amount of gas leakage between the plug **28** and the rod **26**, it should be apparent that a substantial amount of air or gas is trapped in the buffer chamber B behind the front sealing portion **29** of the compensating piston as the recoiling parts of the submachine gun approach their rearmost positions. This is often advantageous since it cushions the rearward movement and prevents damage to the parts.

The portion **29** also has a tendency to cushion forward movement of the compensating piston and the bolt. This tendency is undesirable in some types of weapons particularly where the firing pin is carried by the bolt as in the Thompson M1A1 gun. It is therefore usually preferable to provide gas passages to exhaust fluid from the booster chamber A as the compensating piston moves forward. The vent **35** serves this purpose, permits the escape of the gases from the system after use, and also minimizes the dashpot effect caused by entrapment of gases or air within the system. As the compensating piston moves forwardly from the full recoil position shown in Fig. 7 after the firing of each round, gases in the booster chamber A are exhausted through the port **23** and through the vent **35** to atmosphere until the front portion **29** of the piston blocks the flow. The piston **14** then assumes the normal position before firing as shown in Fig. 4 where any gases in the buffer chamber B are allowed to escape through the grooves **32** and **34** and the vent **35**. In order to reduce the dashpot effect of the booster chamber A and to provide a suitable exhaust through the barrel to atmosphere after the portion **29** passes the port **35**, it is preferable to enlarge the entrance to the passage **33**, for example as in Fig. 4, so that the booster chamber A remains in communication with the bore of the barrel before firing, while the compensating piston moves rearwardly from the position shown in Fig. 5, and while the portion **29** moves forwardly of the vent **35**. Such a construction may be provided by drilling the passage **33** diagonally with a diameter such that the chamber A can exhaust through the port **23** and the barrel when the portion **29** is forward of the vent port **35**. If desired additional vent ports may be provided to exhaust fluid from the booster chamber as will hereinafter become apparent, for example from the description of Fig. 10.

From the foregoing description of the compensating device as applied to the Thompson submachine gun it will be apparent how the device may be employed on many other types of self-actuating firearms by connecting the piston rod or the cylinder of the compensating motor to the actuating mechanism of the firearm for recoiling movement therewith. It will also be understood that gases may ordinarily be led directly from the barrel of most guns to the gas cylinder without the necessity of spaced ports such as **13** and **23** which may be used in guns having a stroke that is long with respect to the barrel.

While the compensating device shown in Figs. 1 to 7 is used as an accessory on an existing submachine gun, it will be understood that such device may be incorporated into the original design of a submachine gun. Figs. 8, 9 and 10 show schematically how the compensating de-

vice may be incorporated into the original design of an automatic or semi-automatic firearm.

Figure 8 illustrates schematically the use of a compensating piston 14 identical with the piston of Figs. 4 to 7 on a different type of gun, like parts of the piston being identified with the same numerals. The piston 14 therefore includes front and rear portions 29 and 30, an inclined passage 33 therethrough leading to a forward booster chamber A, and grooves 32 and 34 leading to a rearward buffer chamber B. A gas-cylinder housing 15' encloses the gas chamber A and B and has an internally cylindrical surface forming a gas cylinder similar to the gas cylinder 15 in which the compensating piston reciprocates. The rear opening in the cylinder housing 15' is closed by an externally threaded bushing plug 28' that is similar to the plug 28 and has a central opening which receives a piston rod 26' similar to the rod 26. The gun illustrated in Fig. 8 is of the "blowforward" type, the cylinder housing 15' being integral with a barrel 6' and being adapted to move forwardly with the barrel after each round is fired. This housing is preferably of light construction so as to increase the inertia only a small amount. It is to be understood that the bore of the barrel 6' may, like the bore of the barrel 6, have conventional rifling including helical lands and grooves which provide substantial friction betwen a projectile, such as a bullet 40, and the barrel. Such barrel may be smoothbored and adapted to fire a shot charge or other suitable projectiles, or may have any other suitable shape. The barrel 6' and the cylinder housing 15' are mounted for reciprocation in unison on the framework of the gun and are allowed to move forwardly after firing. The framework of the gun is firmly attached to a standing breech block 41 and includes a receiver 42 and a barrel housing 43 on which the barrel slides.

The receiver contains, in addition to the breech block, a magazine recess 44 in which cartridges 45 are fed and contains other conventional mechanism for automatically feeding, firing, extracting, and ejecting cartridges as is well understood in the art. The receiver also is formed with a projection that engages in a groove 46 in the rear portion of the rod 26' to secure the compensating piston to the standing breech block.

In order to yieldingly resist movement of the standing breech block 41 rearwardly with respect to the barrel 6' (or of the barrel forwardly with respect to the framework of the gun), it is preferable to provide a driving spring between the barrel and the framework of the gun. As herein shown the barrel housing 43 has a forward portion 47 adapted to slidingly engage the external cylindrical surface of the barrel 6'. The gas cylinder housing 15' is provided with a forwardly projecting driving spring guide pin 48 which fits in a corresponding slot in the forward portion 47 and extends parallel to the barrel. A driving spring 49 is carried by the guide pin 48 between the forward portion 47 of the barrel housing and forward wall of the gas cylinder housing 15'. The housing 15' is provided with ports 23' and 35' similar to the ports 23 and 35 of the housing 15, the port 23' communicating with the bore of the barrel 6' and the vent port 35' communicating with atmosphere. The compensating device shown in the blowforward gun of Fig. 8 therefore functions in a manner similar to the device of Figs. 1 to 7.

When the barrel is in its rearward position and the firing of a cartridge is initiated, the backthrust of the propellant gases is transmitted through the cartridge base to the standing breech 41 and the bullet or projectile 40 is propelled forwardly through the barrel, the friction between the bullet and the barrel causing forward movement of the barrel 6' and the gas cylinder housing 15'. If this friction is below normal because the projectile 40 is undersized or because the rifling is badly worn, the "actuating power" is insufficient and the forward movement of the barrel is not enough for proper functioning of the gun. If the forward movement is below normal, the port 23' will admit high pressure gases to the booster chamber A. If the movement is within a normal range the port 23' will be blocked by the rear portion 30 of the compensating piston as the bullet passes said port. Figure 8 illustrates the position of the compensating piston during travel of the bullet through the barrel where the "actuating power" is excessive beacuse of an oversize bullet, an excessive amount of foreign material in the barrel, an excessive amount of propellant, or for other reasons. In this position gases are admitted to the buffer chamber B through the port 23' and the grooves 32 and 34. It should be apparent that the proper functioning of the gun is assured just as with the compensating device of Figs. 1 to 7.

The application of a compensating device to a locked-breech gas-operated self-actuated firearm is shown schematically in Fig. 9. In this firearm the piston of the compensating device is connected to the barrel and the cylinder for the piston is connected to the recoiling actuating mechanism of the gun, an arrangement that is equivalent to but substantially the reverse of what is shown in Figs. 1 to 7. It will be understood that many other cylinder and piston arrangements equivalent to those illustrated may be used, it being practically impossible to illustrate and describe all possible variations.

Inasmuch as the normal functioning cycle of a conventional gas-operated self-actuating firearm is a matter of general knowledge, a detailed description of the conventional parts of such a gun is believed undesirable and unnecessary for an understanding of the present invention. An examination of Fig. 9 will make clear to anyone skilled in the art that a common type gas-operated weapon has been selected wherein rearward movement of an actuating slide 50 compresses a driving spring 51 and wherein a cam nose 52 on the rear portion of said slide slidingly engages appropriate cam surfaces 53 on the upper portion of a breech bolt 54 to tilt the bolt so that its locking face 55 is moved out of register with a locking shoulder 56 of a receiver 57 and thereafter to draw the bolt rearward to extract and eject the cartridge case. The receiver 57 has a magazine recess 58 containing cartridges 59 and has a forwardly projecting barrel portion 60 to which the cartridges are fed and to which a barrel 61 is attached. A main actuating gas port 62 is drilled through the barrel portion 60 so as to conduct propellant gases to a chamber C formed between the barrel 61 and the slide 50.

The rear portion of the barrel 61 is in the form of an annular sleeve 63 which is internally threaded to receive the externally-threaded end of the barrel portion 60. Adapted to slide over the cylindrical outer surface of the sleeve 63 is an internally-cylindrical annular sleeve 64 having a rear portion 65 integral with the slide 50 for slidingly receiving the barrel portion 60 and for preventing leakage of gas from the chamber C around the barrel. The barrel portion 60, the sleeve 63, and the sleeve 64, and the port 62 therefore provide a main actuating motor for moving the slide 50, the sleeve 63 serving as the piston of a single-acting fluid motor. The receiver 57 is preferably provided with a forward housing portion 66 enclosing the slide 50, the driving spring 51, and the sleeves 63 and 64. The above described parts of the gas-operated gun are conventional, the gun having additional parts for automatically feeding, firing, ejecting, extracting, and performing the other required actions in the operating cycle.

The compensating device for the gas-operated firearm of Fig. 9 comprises a double-acting reciprocating-piston fluid compensating motor 67 having an annular compensating piston 68 integral with the barrel 61 and a gas cylinder formed by the sleeve 64. The sleeve 64 has an enlarged cylindrical bore 69 coaxial with the barrel 61 in which the piston 68 reciprocates. Internal threads are provided in the sleeve 64 forwardly of the bore 69 to receive an externally threaded bushing plug 70 which

slidingly engages the circumference of the barrel to prevent leakage therethrough. A compensating port 71 is formed in the piston 68 for conveying propellant gases from the bore of the barrel 61 to opposite faces of the piston. In order to permit the piston 68 to function as a piston-type valve as in the previously described compensating devices, a booster channel or groove 72 is machined in the rear portion of the bore 69 to convey powder gases from the port 71 to a booster chamber A' behind the piston, and a buffer channel or groove 73 is machined forwardly of the groove 72 to convey gases to a buffer chamber B', an uncut portion 74 of the sleeve 64 being provided between the grooves to cut off the flow of gases and render the motor ineffective when the "actuating power" is within a normal range.

The compensating device of Fig. 9 is adapted to perform substantially the same function as the compensating devices of Figs. 1 to 8, inclusive, and is obviously equivalent to these devices since it performs substantially the same function in substantially the same manner to obtain similar results. At the moment of firing a cartridge 59 is supported by the breech bolt 54 and the booster chamber A' communicates with the atmosphere through the booster channel 72, the compensating port 71, and the bore of the barrel as illustrated in Fig. 9. This communication is not cut off during travel of a bullet through the barrel if the "actuating power" is below normal. It will be noted that a bullet or projectile in its passage through the barrel will pass and uncover the main gas port 62 of the main actuating motor. At this time the propellant gases pass into the chamber C and cause rearward movement of the slide 50, the sleeve 64, and the bolt 54, the amount of rearward movement depending to some extent on the wear on the port 62 and on other parts of the main actuating motor. If this rearward movement is inadequate or below normal, the booster channel 72 will not be moved out of register with the port 71 by the time the projectile passes the port 71. If the "actuating power" is within a normal range at the time the bullet passes the compensating port 71, the uncut portion 74 will cut off the flow of gases from the barrel to the auxiliary compensating motor so that the motor is ineffective to modify normal operation of the gun. If this power is excessive at this time, the port 71 will register with the buffer channel 73 to admit fluid to the buffer chamber B'. Expansion of the propellant gases in the latter chamber will tend to reduce the movement and the velocity of the actuating mechanism of the gun.

It should be noted that the compensating device of Fig. 9 has been simplified by the omission of vent ports similar to the above described ports 35 and 35' although it is obvious that the compensating piston 14 and its associated ports could be employed if desired on the type of gun shown in Fig. 9 and that vent ports or passages could be used in the compensating device of Fig. 9, if desired, to permit the exhaust of gases around the outer surface of the barrel. The exhausting of fluid from the chambers A', B' and C to atmosphere is primarily through the bore of the barrel. Chambers A' and B', for example, exhaust primarily through the port 71 although there is a certain amount of leakage between the plug 70 and the exterior of the barrel 61 to limit the pressure of the gases which may be trapped in the chamber B'. If desired suitable vent flutes may be provided at appropriate points in the exterior surface of the barrel.

From the above description it will be obvious that the compensating device of Fig. 9 may be readily applied to other types of guns and especially to a locked-breech recoil-operated gun where the main actuating motor of Fig. 9 is omitted and the recoil alone is normally sufficient to operate the actuating mechanism of the gun satisfactorily. If the main actuating motor is to be retained, the gas-operation and power-modification system of Fig. 9 could be readily adapted to a gas-operated forward-moving-barrel gun.

It should be obvious that the buffer or the booster function of each of the above described compensating devices of Figs. 1 to 9 could be omitted, if desired, whereby the compensating force is obtained in one direction only and that the shut-off and the size of the neutral range during the firing of normal ammunition could be varied or considerably reduced. Figure 10 illustrates the omission of the buffer function and the use of a single-acting compensating motor 76 having a booster chamber A'' for receiving powder gases from the barrel. Since the operation of the device shown in Fig. 10 will be apparent from the foregoing description of Figs. 1 to 9, the conventional parts of the self-actuating gun to which the compensating device of Fig. 10 is applied have been omitted. The motor 76 has a compensating piston 77 which could be readily substituted for the piston 14 of Figs. 4 to 7, for example. However, it has been found more desirable and more convenient to show the compensating motor incorporated into the original design of a gun as done in Fig. 8. The cylinder of the motor 76 is formed by a gas cylinder housing 78 similar to the housing 15' and which is integral with a barrel 79 similar to the barrel 6'. A piston rod 80 similar to the rod 26' extends through the housing 78 parallel to the barrel and is connected to the gun in such a way that the compensating piston moves rearwardly with respect to the barrel in unison with the actuating mechanism of the gun. The compensating device of Fig. 10 is therefore adapted to be used on almost any type of self-actuated firearm (including the blowforward arm of Fig. 8) to compensate for insufficient actuating power.

The compensating piston 77 is cylindrical in form and is of substantially uniform diameter throughout its length so as to permit the use of a simplified gas cylinder housing 78, the piston reciprocating in the internal cylindrical bore of the housing and having gas seals including one or more annular labyrinth grooves 81 in the rear portion thereof to reduce gas velocity and to prevent rapid leakage of high pressure gases from the chamber A''.

The housing 78 is provided with a gas port 82 and front and rear vent ports 83 and 84 for conveying fluid to and from the fluid motor 76. External gas passages may be employed to convey gases from the barrel through the port 82 to the chamber A''. However, as herein shown, internal passages are employed including a central horizontal passage 85 and a transverse passage 86 extending clear through the piston. The ports 82 and 84 are preferably so arranged that the internal passages in the compensating piston are symmetrical whereby the piston may be assembled in more than one position, for example with the piston upside down.

Before firing a round the port 82 registers with the passage 86 and the chamber A'' communicates with atmosphere through the barrel. If after firing a round the "actuating power" is below normal, the piston 77 and the actuating mechanism of the gun will not have moved far enough to move the pasage 86 out of register with the port 82 by the time the bullet passes the port 82. High pressure gases will therefore enter the booster chamber A'' through the passages 85 and 86 and actuate the compensating piston in a rearward direction. If the "actuating power" is within a normal range the piston will block off the port 82 as the bullet passes this port as illustrated in Fig. 10. In any position of the piston 77 forwardly of the port 84, the communication between the port 82 and the vent ports 83 and 84 will be cut off. If desired, the additional port 84 may be omitted, but this port is often very desirable. After firing a round having insufficient actuating power, the high pressure gases admitted to the chamber A'' must actuate the piston 77 during a portion of its stroke. These gases may be exhausted a short time thereafter and before the

piston completes its rearward movement. The port 84 registers with the passage 86 and exhausts the powder gases from the booster chamber as the piston completes its rearward movement. The port 84 also assists the port 83 in exhausting the booster chamber as the piston moves forwardly so as to minimize any dashpot effect. A dashpot effect due to closing of the port 83 by the piston is avoided since the passage 86 registers with the port 82 to exhaust the booster chamber after the piston has closed the port 83. However, it should be noted that the port 83 is closed before the port 86 registers with the port 82 and that any communication between the port 82 and the vent 83 is prevented.

It will be apparent that the amount of energy needed to provide proper operation of the main actuating mechanism of a self-actuating firearm will vary if there is any variation in the position of said actuating mechanism at any predetermined time either before or after firing of a round of ammunition. The compensating devices of the present invention correct for changes in the actuating power required for proper functioning of a self-actuating firearm by modifying the action of the main actuating mechanism of the gun automatically after firing in accordance with the position of such mechanism when the projectile passes a predetermined point in the barrel.

As shown in the drawings, the flow of motive fluid to the compensating motor is regulated in accordance with the position of the main actuating mechanism as the projectile passes the gas intake port leading to the motor. Where the gas port is located a substantial distance downstream of the normal position of the projectile at the instant of firing (for example, a distance greater than about six or seven times the diameter of the projectile as illustrated in connection with each of the forms of the invention shown in Figs. 1 to 10), the position of the actuating mechanism at the instant the projectile passes the gas port will vary because of variation in the amount of movement of the actuating mechanism after firing (for example, due to changes in bullet weight, changes in the frictional resistance to bullet movement, changes in the combustion rate, changes in the amount of strength of the propellant charge, etc.). The compensating devices of Figs. 1 to 10 correct for such variations and also correct for variations in the position of the actuating mechanism after firing due to changes in the initial position of the actuating mechanism before firing (for example, due to changes in the length of the cartridge case or obstructions which prevent full forward movement of the bolt and/or the cartridge case).

Where the gas port supplying motive fluid from the barrel to the compensating motor is located adjacent to or relatively close to the normal position of the projectile at the instant of firing (for example, a distance less than about three times the diameter of the projectile), the compensating device may be controlled accurately to correct for changes in the actuating power required which changes are due to variations in the position of the actuating mechanism before firing but may not be controlled with great accuracy to correct for changes in the rate of movement of the parts after firing. It will be apparent that the amount of movement of the main actuating mechanism during forward movement of a projectile to the gas port is a better indication of the rate of movement of such mechanism if the port is spaced a larger distance from the breech end of the barrel and that the port may be relatively close to said breech end if compensation only for changes in the initial position of the actuating mechanism is desired.

Figures 11 to 14 illustrate in schematic form a blowback firearm having a compensating device thereon which is designed primarily to modify the operation of the main actuating mechanism of the firearm in accordance with changes in the initial position thereof before firing, but it will be understood that such a device may also compensate for variations in the rate of movement of the actuating mechanism after firing, the amount of compensation for such movement depending on how far the gas port 23*a* is spaced from the firing chamber at the breech end of the barrel.

The blowback firearm includes a receiver 87, a forwardly extending barrel 88 having a bore 89, a bolt 90, mounted for reciprocation in the receiver, a driving spring or bolt return spring 91 for yieldably resisting rearward movement of the bolt, and a magazine recess 92 for receiving rounds of ammunition 93 to be fired in the barrel. It will be understood that the main actuating mechanism of the self-actuating firearm shown in Figs. 11 to 14 has, in addition to the bolt (which forms part of the main motor of the firearm) and its spring 91, the conventional elements of a blowback firearm for feeding, locking, firing, extracting, ejecting, and/or cocking so as to permit automatic and/or semi-automatic operation. For example, such main actuating mechanism may be similar to that used in a conventional Thompson M1 or M1A1 submachine gun of the type shown in Figs. 1 to 3.

The barrel 88 is provided with a conventional counterbore 96 at the breech end thereof which forms a firing chamber for slidably receiving the cartridge case of each round of ammunition and for guiding the projectile axially into the rear end of the bore 89 which preferably is provided with conventional rifling. An annular shoulder 97 is formed between the bore and the counterbore at the front of the firing chamber having a substantially vertical annular surface engageable with the front of the cartridge case to limit forward movement thereof.

During normal operation of the firearm with regular size cartridge cases, the bolt 90 during its advancing movement engages the rear face of a cartridge leaving the recess 92 and moves the cartridge forwardly into the firing chamber at the breech end of the barrel until the cartridge case engages the shoulder 97 substantially as shown in Fig. 13. Of course, a compensating device would not be needed and could be omitted if the firearm functioned in its normal manner at all times and there were no abnormal conditions likely to cause malfunctioning of the main actuating mechanism.

As shown in Figs. 11 and 12, the blowback gun is firing a round having an abnormally short cartridge case 94 and a normal size bullet or projectile 95. Since there is nothing associated with the loading of such round to obstruct or to limit the forward movement of the bolt and other parts of the main actuating mechanism until such mechanism has moved forwardly beyond its normal firing position, malfunctions are likely to occur unless a compensating device is provided for increasing the amount of actuating power.

The blowback gun of Figs. 11 to 14 is provided with a compensating device similar to that shown in Figs. 1 to 8 and including a double-acting compensating piston 14*a*, a gas cylinder housing 15*a* in which the piston reciprocates, a piston rod 26*a* rigidly connecting the piston to the bolt 90, and an externally threaded gas cylinder plug 28*a* which is screwed into the rear end of the gas cylinder 15*a*. The cylinder and piston form a double-acting auxiliary fluid motor for modifying the operation of the main actuating mechanism of the gun. Motive fluid for the compensating motor is supplied from the bore 89 by means of a gas intake port 23*a* located forwardly and downstream of the shoulder 97 of the firing chamber. The gas port may be located at any suitable distance from the shoulder but is shown herein as being spaced therefrom by a distance about four times the diameter of the bore 89 whereby the projectile must travel a distance about four times its diameter before the port 23*a* is uncovered and exposed to the high pressure powder gases.

The compensating piston 14*a* is similar to the piston 14 previously described and functions in a similar manner as a valve for controlling the flow of motive fluid to the compensating motor in accordance with the position of the main actuating mechanism when the projectile passes

the gas intake port 23*a*. The member 14*a* functions as a piston-type valve and has front and rear port-closing cylindrical portions 29*a* and 30*a* and an intermediate cylindrical portion 31*a* corresponding to the portions 29, 30 and 31, respectively, of the piston-valve 14. The compensating piston 14*a* also has an internal passage 33*a* similar to the passage 33 which extends from the rear portion 30*a* to the front face of the piston for conveying powder gases from the port 23*a* to a booster chamber A_2 at the forward end of the gas cylinder. An external longitudinal groove or passage 34*a* extends from an annular groove 32*a* between the front and rear portions 29*a* and 30*a* to the rear face of the piston 14*a* for establishing communication between the port 23 and a buffer chamber B_2 at the rear end of the gas cylinder. The gas cylinder housing 15*a* is provided with a vent port or aperture 35*a* similar to the port 35 which is adapted to permit the escape of gases to atmosphere. It will be noted that the piston valve cuts off communication between the port 23*a* and the port 35*a* whenever a portion of the valve is forwardly of the port 23*a*. The vents 35*a* remove gases from the system after use and minimize the dashpot effect due to entrapment of gases or air within the system.

Figures 12, 13 and 14 illustrate three different alternatives which may present themselves during firing of the blowback firearm of Fig. 11. The main actuating mechanism of the gun is shown in Fig. 13 in its normal position before firing a normal size cartridge, and is shown in Figs. 12 and 14 in abnormal positions a short distance forwardly and rearwardly, respectively, of its normal position.

When an ordinary round is employed having a normal length cartridge case for which the main actuating mechanism of the gun was designed, it is preferable to render the compensating device ineffective. As shown in Fig. 13, a standard cartridge is employed having a case 98 and a bullet 99 of normal size. The front end of the cartridge case 98 engages the shoulder 97 of the barrel to stop the forward movement of the bolt 90 and other parts of the main actuating mechanism when the parts reach their normal positions before firing. After firing the normal round, the port 23*a* is out of register with the groove 32*a* and the passage 33*a* and is closed by the rear portion 30*a* of the compensating piston 14*a* when the bullet 99 passes the port 23*a* as shown in dotted lines in Fig. 13, whereby the flow of high pressure gases to the booster and buffer chambers A_2 and B_2 is prevented and the compensating motor is substantially ineffective to modify the operation of the main actuating mechanism of the gun.

When a short cartridge case 94 is employed as shown in Fig. 12, the main actuating mechanism including the bolt 90 is located forwardly of its normal initial position before firing, and the passage 33*a* moves into register with the port 23*a* when the bullet 95 moves beyond the port to the position shown in dotted lines in Fig. 12. The high pressure combustion gases therefore are admitted to the booster chamber A_2 from the barrel to increase the actuating power. This compensates for the increase in the required actuating power due to movement of the actuating mechanism too far forward before firing and/or due to the reduction of the strength of the propellant charge in the shorter case 94.

Figure 14 illustrates the position of the actuating mechanism and other parts of the gun after firing a round which was not properly seated against the shoulder 97 of the barrel at the instant of firing. It should be apparent that the amount of actuating power required by the main actuating mechanism to extract and to eject the cartridge case and to perform other actions in the functioning cycle is reduced when the actuating mechanism is located rearwardly of its normal initial position at the instant of firing. When such a condition exists the compensating piston and the main actuating mechanism connected thereto are located rearwardly of their normal positions as the projectile passes the gas port 23*a*, and the annular groove 32*a* registers with the port 23*a* to conduct high pressure combustion gases to the buffer chamber B_2 rearwardly of the piston so as to resist rearward movement of the bolt 90 and other parts of the main actuating mechanism.

As shown in Fig. 14, the bolt 90 and the piston 14*a* are located rearwardly of their normal positions during firing of a cartridge having a normal length case 100 and a normal size bullet 101, and the buffer chamber B_2 communicates with the bore 89 when the projectile 101 arrives at the position as shown adjacent the port 23*a*. A similar situation exists whenever the main actuating mechanism is displaced rearwardly a small distance from its normal position at the instant of firing whether such a condition is due to the use of a cartridge case having an abnormal length greater than that of the cartridge case 98 or 100 or is due to some other obstruction in the bolt way or in the firing chamber which prevents full forward movement of the main actuating mechanism of the gun before firing. Such an obstruction may be due for example to a change in the shape of the cartridge or cartridge case. Since the gas port 23*a* is spaced from the shoulder 97 and from the initial position of the projectile at the instant of firing, the condition illustrated in Fig. 14 may also be wholly or partially due to an overly powerful propellant charge which moves the actuating mechanism rearwardly of its normal position as the projectile 101 travels just beyond the gas port. However, the compensating device of Figs. 11 to 14 is primarily designed to correct for changes in the position of the main actuating mechanism at the instant of firing since the port 23*a* is relatively close to the shoulder 97.

A gun of the type shown in Figs. 11 to 14 may be designed to fire cartridges having at least three substantially different size cartridge cases (for example, (1) a normal cartridge case of such a length and containing a propellant charge of such strength that the main actuating mechanism operates the gun satisfactorily when the compensating device is in cut-off position or is rendered ineffective; (2) an overly powerful cartridge whose case is abnormally long or longer than that for which the main actuating mechanism was designed; and (3) a weak cartridge whose case is abnormally short). This feature may be very important since it permits the use of abnormal cartridges when the regular cartridges are not available or do not have the muzzle velocities most desirable for the intended use.

The piston 14*a* functions substantially the same as the piston 14, the portion of the piston between the groove 32*a* and the inlet end of the passage 33*a* closing the outlet end of the gas port 23*a* when the main actuating mechanism of the gun has a position within a normal range as the projectile passes the port so as to cut off communication between the bore 89 of the barrel and the booster and buffer chambers A_2 and B_2. Such an arrangement permits admission of high pressure gases to the booster or buffer chamber of the compensating motor whenever the position of the actuating mechanism is a short distance outside said normal range as the projectile passes the gas port and corrects both for variation in the position of the main actuating mechanism before firing and for variation in the amount of movement of the main actuating mechanism after firing and before energizing of the compensating motor.

Figures 15 and 16 illustrate in schematic form a blowback firearm of the type shown in Fig. 11 having a single-acting compensating motor which will correct only for changes in the initial position of the main actuating mechanism before firing since the gas port is located adjacent the position of the projectile at the instant of firing.

The blowback firearm includes a receiver 102, a forwardly extending barrel 79*a*, a bolt 103 mounted for reciprocation in the receiver, and a driving spring or bolt return spring (not shown) for yieldably resisting rear-

ward movement of the bolt. The barrel 79*a* is provided with a conventional counterbore 104 at the breech end thereof which forms a firing chamber for slidably receiving the cartridge case of each round of ammunition and for guiding the projectile axially into the rear end of the barrel bore. The annular shoulder formed at the front of the firing chamber between the bore and the counterbore is engageable with the front of the cartridge case to limit the forward movement thereof.

The blowback gun of Figs. 15 and 16 is provided with a compensating device similar to that shown in Fig. 10 and including a single-acting fluid compensating motor and a gas intake port 82*a* for supplying motive fluid to the motor from the bore of the barrel. However, unlike the device shown in Fig. 10 in which the gas port 82 is located a substantial distance downstream from the position of the projectile at the instant of firing (for example, a distance more than five times the diameter of the projectile), the compensating device of Figs. 15 and 16 has its gas port 82*a* very close to the position of the projectile at the instant of firing (a distance from the counterbore 104 less than the diameter of the projectile as shown herein).

The compensating device of Figs. 15 and 16 comprises a compensating piston 77*a*, a gas cylinder housing 78*a*, a piston rod 80*a* integrally connected to the bolt 103, a gas port 82*a*, a vent port 83*a*, a central horizontal passage 85*a*, and a transverse passage 86*a* corresponding to the previously described elements 77, 78, 80, 82, 83, 85 and 86, respectively, and functioning in a similar manner. However, the piston rod 80*a* is integral with and the same diameter as the piston 77*a* and is mounted on the gun so that the rod and the piston may slide rearwardly out of the gas cylinder housing 78*a* during reciprocation of the bolt 103, such housing having an internal diameter throughout its length substantially equal to the external diameter of the piston to permit such sliding. Such a construction is preferable where the forward end of the compensating piston is close to the bolt and to the breech end of the barrel.

Figure 15 shows the position of the bolt 103 of the main actuating mechanism of the gun and the position of the compensating piston 77*a* at the instant of firing a round of ammunition having a short cartridge case 105 and a normal size bullet or projectile 106. With the actuating mechanism in this position the piston 77*a* serves as a valve for establishing communication between the bore of the barrel and a booster chamber A_3 at the front of the housing 78*a*.

Figure 16 shows the positions of the parts just before firing a round having a normal length cartridge case 107 and a normal size bullet 108, the piston-type valve 77*a* blocking off communication between the bore of the barrel and the booster chamber. The front portion of the compensating piston extending from the passage 86*a* to the front face of the piston has a sliding fit in the gas cylinder and sealingly engages the cylinder like the portions 29 and 29*a* of the pistons, previously described whereby communication between the ports 82*a* and 83*a* is cut off whenever the front face of the piston is forwardly of the port 82*a*. Said front portion also cuts off communication between the port 82*a* and the booster chamber A_3 whenever the positions of the bolt 103 and other parts of the main actuating mechanism of the gun are within the normal range for which the mechanism was designed at the instant of firing. When the positions of said parts are abnormal and rearwardly of the positions shown in Fig. 16, the port 82*a* registers with the passage 86*a* as the projectile passes the port to energize the compensating motor and to modify the rearward movemen of the bolt. This compensates for a reduction in the strength of the propellant charge which may accompany a reduction in the length of the cartridge case. When the cartridge case is of normal length and has a propellant charge of normal strength, the compensating motor is ineffective when the projectile passes the port 82*a* so that the main actuating mechanism may act in the normal and conventional manner without modification.

It will be noted that the various compensating devices shown in Figs. 1 to 16 are substantially equivalent and function in substantially the same way to obtain similar results. The gas intake port leading to the compensating motor may be located at any desired distance from the firing chamber or from the normal position of the cartridge case at the instant of firing. If the port is located a substantial distance from the initial position of the projectile, the compensating device may accurately correct for variation in the amount of movement of the main actuating mechanism during movement of the projectile to the port. Regardless of the distance from the port to the initial position of the projectile the compensating device may be designed to correct for variation in the initial position of the actuating mechanism at the instant of firing or for variation in the strength of the powder charge which accompanies variation in the length of the cartridge cases.

It is to be understood that in accordance with the provisions of the patent statutes, variations and modifications of the specific devices herein shown and described may be made without departing from the spirit of the invention.

Having described my invention, I claim:

1. An actuating-power-variation compensating device for a self-actuating firearm having a barrel through which a projectile fired from an individual round of ammunition travels, a feed opening through which each round is fed to said barrel, and means for covering said opening including reciprocable actuating means responsive to the actuating power supplied by the expanding propellant gases and movable axially relative to the barrel during the travel of the projectile through the length of the barrel a distance substantially proportional to said actuating power for causing uncovering of said opening automatically while said compensating device is substantially ineffective during normal firing of a round for which the firearm is designed, said compensating device comprising: means for modifying movement of said actuating means including a closed gas cylinder and a piston mounted to reciprocate in said cylinder, said piston and cylinder defining an expansible chamber at one end of said piston for receiving high pressure gases to actuate said piston, means connecting said piston to said actuating means for reciprocation in unison therewith relative to said barrel, means holding said cylinder against movement relative to said barrel, valve means formed by portions of said piston and cylinder for controlling flow of gases to said expansible chamber in accordance with the position of said piston relative to said cylinder, and means for supplying motive fluid from the barrel to said pressure chamber including a gas intake port in said barrel downstream of the projectile at the instant ignition is initiated and a passage leading from said port to said cylinder for establishing communication between said expansible chamber and the interior of said barrel, said actuating means moving said piston relative to said cylinder during said normal firing from its original position at the instant ignition is initiated to a second position in the period of time required for the projectile to move from the cartridge case to said gas port, said valve means preventing flow of gases from the barrel through said gas port when the piston is in said second position to render said compensating device ineffective during said normal firing, said valve means establishing communication between said barrel and said expansible chamber when said piston is in a third position relative to said barrel which is spaced from said second position, said actuating means causing movement of said piston during firing between said second and third positions and beyond said positions, said expansible cham-

ber being located on the end of the piston wherein the chamber increases in size as said piston moves in a direction from said third to said second position.

2. The combination defined in claim 1 wherein said expansible chamber is a buffer chamber located on the end of said piston to cause the piston to decrease the movement of said actuating means when the propellant gases are admitted to said chamber.

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