April 30, 1968 L. BUCKLISCH ET AL 3,380,344

PRESSURE CONTROL DEVICE

Original Filed Oct. 1, 1964

FIG. 1a

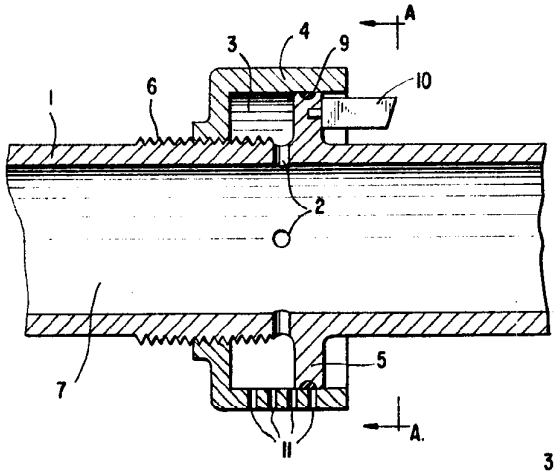
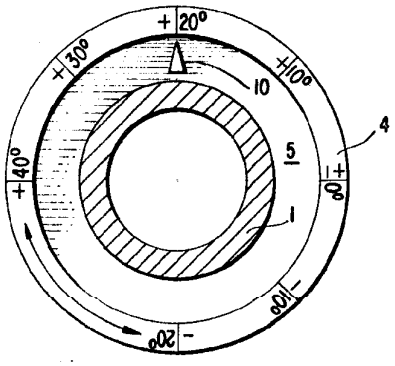


FIG. 1b



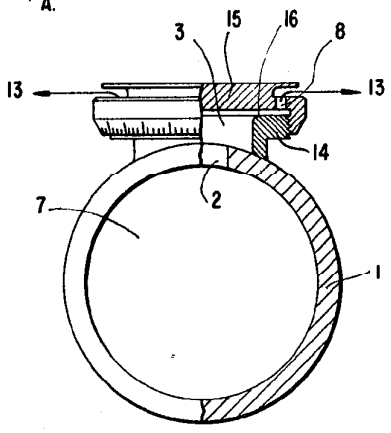


FIG. 2

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PRESSURE CONTROL DEVICE

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Original application Oct. 1, 1964, Ser. No. 400,745, now Patent No. 3,307,451, dated Mar. 7, 1967. Divided and this application Jan. 3, 1967, Ser. No. 630,152
Claims priority, application Germany, Oct. 2, 1963, D 42,618
9 Claims. (Cl. 89—14)

ABSTRACT OF THE DISCLOSURE

A device for influencing the pressure of propellent charge gases within a barrel wherein an auxiliary pressure chamber is arranged outside of the barrel projectile guiding bore for allowing expansion of the propellant gases passing through an interconnecting aperture. The auxiliary chamber may be changed in volume and additionally have an adjustable aperture for allowing escape of the gases from the auxiliary chamber to the atmosphere to compensate for variations in propellent charge temperature. An indicator may be coupled to the adjustment for correlation with selected propellent charged temperatures.

The present application is a division of application Ser. No. 400,745 filed Oct. 1, 1964, by the present inventors on a "Pressure Control Device," now Patent No. 3,307,451.

Background of the invention

The starting velocity of a shell or projectile which is fired out of a barrel depends, as known, on the pressure which develops during the burning of the propellent charge powder. This pressure, in turn, depends on the prevailing temperature of the propellent charge powder which is the reason why shells or projectiles of one and the same type with different firing temperatures of the propellent but otherwise under completely identical conditions have a different starting velocity resulting in very considerable differences as regards firing accuracy, penetrating force and flight distance of the shell or projectile in addition to strongly varying loads of the gun barrel.

In order to avoid these disadvantages one seeks to achieve, over the range of all firing temperatures of the propellent charge powder that possibly occur in practice, a constant starting velocity of the shells or projectiles. A known measure to influence the starting velocity of a projectile in this sense resides in the use of partial charges of differently rapidly burning propellent charge powders. With recoilless guns there has been used with good success for propellent powder charges of predetermined size also a change in the inertia mass corresponding to the temperature differences. Both prior art measures have, however, the considerable disadvantage that they require a supply maintenance and experimentation of additional charge or inertia elements which represents a considerable inconvenience and burden for a field-type deployment or for combat action of the troops.

Summary of the invention

According to the present invention there is proposed a mechanism for influencing the pressure of propellent charges for projectiles to be fired from a barrel which can be manipulated in simple manner similar to a range finder adjustable to a desired distance. The mechanism according to the present invention is characterised in that the

pressure space for the propellent charge is connected for the purpose of discharge or release of a variable quantity of propellent charge gases through one or several apertures, bores or the like arranged in the wall of the gun barrel with an additional pressure space closed off against the outside or also connected with the atmosphere by further apertures, bores or the like or also directly with the atmosphere.

By means of the device of the present invention, one can readily control and always accurately adjust, by simple discharge or outflow of a corresponding quantity of the gases developing during burning of the propellent charge powder out of the pressure space for the propellent charge, the pressure of the propellent gases within the pressure space corresponding to the prevailing firing temperature of the propellent charge powder to such a value that the projectile always has the same starting velocity. If, for example, one intends to let the excess quantity of propellent gas flow out or escape directly into the atmosphere, then only the apertures, bores or the like connected with the pressure space have to be constructed with adjustable outflow cross section and the prevailing free outflow cross section has to be adjusted correspondingly, which can take place, for example, in such a manner that a threaded ring is arranged on the gun barrel which, depending on the adjustment in the one or the other direction, frees or opens up a greater or smaller number of correspondingly arranged apertures of the gun barrel.

In the interest of as little as possible an impairment of the rigidity of the gun barrel and also in the interest of as little as possible an endangering of the operating personnel by the high pressure of the outflowing or released propellent gases, it may, however, also be advisable not to let the excess quantity of propellent charge escape into the atmosphere or at least to let the same flow out into the atmosphere only indirectly by way of an auxiliary pressure space connected with the main pressure space. In that case, use may be made of various measures. For example, the pressure space may be connected with an auxiliary pressure space which is closed, completely tight with respect to the outside atmosphere and of constant volume, though of sufficient volume for all possible applications, in that the excessive propellent gas quantity is then let off or released by way of bores of adjustable flow cross section. In lieu thereof, however, the volume of the auxiliary pressure space may be made adjustable and the flow cross section of the apertures, bores or the like can then, instead, be kept constant. Finally it is also possible to render adjustable both the volume of the auxiliary pressure space as well as also the flow cross section of the bores.

An excessively high load of the auxiliary pressure space by the propellent gas quantity let out of the pressure space can be avoided in that at least a part of this excess propellent gas quantity is permitted to flow out of the auxiliary pressure space into the atmosphere. In that connection the present invention proposes to construct the bores or the like provided in the walls of the auxiliary pressure space with adjustable flow cross section and according to a further feature of the present invention to couple the change of the flow cross section with the change in volume of the auxiliary pressure space whereby not only an excessively high load is avoided but above all also a constant loading is achieved.

In all cases the arrangement will appropriately be made in such a manner that the predetermined, non-adjustable volume of the pressure space corresponds to the desired starting velocity of the projectile at the lowest possible

temperature of the propellent charge powder so that with a normal temperature always a portion of the propellent charge gases has to flow out in order to achieve the required starting velocity of the projectile or shell. This measure is necessary if an influencing of the pressure of the propellent charge gases is to be possible in the sense of a constant starting velocity of the projectile or shell both at higher as well as at lower temperatures than the normal temperature.

Accordingly, it is an object of the present invention to provide a pressure control mechanism adapted to control the pressure of the propellent for shells and projectiles in such a manner as to avoid by extremely simple and inexpensive means the shortcomings and drawbacks encountered with the prior art constructions.

It is another object of the present invention to provide a pressure control means for the propellent gases of shells and projectiles which is not only simple in construction but also operationally reliable as well as easy to handle and adjust.

A further object of the present invention resides in the provision of a control mechanism operable to maintain constant the starting velocity of a projectile to be fired from a barrel regardless of prevailing temperature while simultaneously preventing any considerable changes in the loads and stresses to which the gun is subjected, particularly as regards the gun barrel.

A still further object of the present invention resides in the provision of a gun capable, by simple means, of compensating for temperature changes affecting the propellent thereby improving the firing accuracy, penetrating force and flight distance of the projectiles or shells thereof.

Another object of the present invention resides in the provision of a pressure control device for guns which requires no experimentation, testing or cumbersome storing facilities to assure at all times the same starting velocity for the shells or projectiles thereof.

Still another object of the present invention resides in the provision of a pressure control and adjusting device for guns adapted to maintain essentially constant the starting velocity of the projectile to be fired, which is simple in its adjustment as well as safe for the operating personnel.

Brief description of the drawing

These and other objects, features and advantages of the present invention will become more obvious from the following description when taken in connection with the accompanying drawing which shows, for purposes of illustration only, several embodiments in accordance with the present invention, and wherein

FIGURE 1*a* is an axial longitudinal cross sectional view of a first embodiment of an adjusting mechanism in accordance with the present invention in which the influence of the pressure of the propellant gas takes place by means of an auxiliary pressure space surrounding the gun barrel in a ring-shaped manner;

FIGURE 1*b* is a cross sectional view taken along line A—A of FIGURE 1*a*; and

FIGURE 2 is a transverse cross sectional view through a modified embodiment of a pressure control mechanism in accordance with the present invention having an auxiliary pressure space mounted over the gun barrel.

Detailed description of the drawing

Referring now to the drawing wherein like reference numerals are used throughout the various views to designate like parts, and more particularly to FIGURE 1, reference numeral **1** designates therein the gun barrel which is provided with radial bores **2**; the bores **2** are arranged at the place of the highest starting pressure of the propellant powder gases developing during the burning of the propellant charge (not shown) and connect the inside of the barrel or the pressure space **7** with the auxiliary pressure space **3** formed by the barrel **1**, the flange **5** provided on the barrel **1** as well as the annular housing **4** threadably mounted on the coarse thread **6** of the barrel **1**. The volume of the auxiliary pressure space **3** is adjustable by rotating the annular housing **4** with respect to the barrel **1**. The flange **5** is sealed with respect to the annular housing **4** by means of the annular seal **9**. Under certain circumstances it may also be appropriate to provide an annular seal between the barrel **1** and the annular housing **4**.

Upon a corresponding rotation of the annular housing **4** on the barrel **1** the auxiliary pressure space **3** decreases, whereby simultaneously the charge density is increased. Inversely the charge density decreases with an increase of the auxiliary pressure space **3** by an opposite rotation of the annular housing **4**. The starting velocity of the projectile or shell may be influenced by means of this change in the charge density in the sense that it always has the same magnitude within the entire range of the normally occurring temperatures of the propellant charge powder, for example, from —20° C. up to +40° C. The volume of the auxiliary pressure space **3** corresponding to the respective temperature of the propellant charge powder can be adjusted by means of the temperature scale arranged at the rear end of the annular housing **4** (FIGURE 1*b*) in a most simple manner and to the correct magnitude whereby the indicator mark **10** secured at the flange **5** indicates always the condition under which the firing takes place.

In those cases in which a change of volume of the auxiliary pressure space **3** does not by itself suffice to influence the effect of the propellant charge in the desired sense, the radial bores or apertures **11** may be provided—as shown in dash and dot line in the lower half of FIGURE 1*a*—in the walls of the annular housing **4**. As may be readily seen from FIGURE 1*a*, the flange **5** upon rotation of the annular housing **4**, that is, with a change of the volume of the auxiliary pressure space **3**, frees or opens up a more or less large total cross section of the apertures **11** so that a more or less large portion of the propellant charge gases can escape into the atmosphere. It is recommended in practice to construct the apertures **11** with an approximately square or rectangular cross section and to stagger or offset the same in the circumferential direction with respect to one another in such a manner that the end of one aperture coincides accurately in the axial direction with the beginning of the aperture. In this manner a linear relationship is established between the change in volume of the auxiliary pressure space **3** and the change of the free cross section of the discharge apertures **11**, whereby the pressure of the propellant charge gases can be changed continuously, that is, without pressure gaps. A disturbance of the predetermined relationship between powder temperature and charge density does not occur by reason of the arrangement of the discharge apertures **11** since the pressure decrease takes place linearly with partial discharge of the propellant gases.

The embodiment illustrated in FIGURE 2 of the mechanism according to the present invention is advantageous especially in those cases in which a considerable decrease of the charge density is not possible without endangering thereby the regular combustion process of the propellent powder. With this mechanism the auxiliary pressure space 3 is constituted by the threaded stud or connection **14** arranged on the barrel **1** at the place of the highest starting pressure, in this embodiment, for example, welded thereon—and by the cover **15** provided with discharge apertures **8** and threaded on the stud or connecting piece **14**. The auxiliary pressure space **3** is in communication with the pressure space **7** on the inside of the gun barrel **1** by way of a bore **2** having a constant cross section. The volume of the auxiliary pressure space **3** participating in determining the charge density is changed only slightly by rotating the cover **15** on the threaded stud or connection piece **14** whereby the end surface of the cover **15** and the oppositely disposed end surface of the threaded stud **14** form together an annular

nozzle insofar as the cover **15** is not screwed-in up to the mutual abutment of the two end surfaces. This annular nozzle has its smallest cross section along the inner edge **16** of the threaded stud or connecting piece **14** whereby the respective size of the cross section is determined, in addition to being determined by the inner diameter of the threaded stud **14**, also by the respective distance between the oppositely disposed end surfaces of the cover **15** and of the threaded stud **14**. The distance between these end surfaces and therewith also the nozzle cross section can be changed within the given limits at will and continuously by rotating the cover **15**. These limits are in practice a cross section of zero, that is, a closed nozzle for firing at the lowest powder temperature to be considered, and the nozzle cross section of such size that upon firing of the powder at the highest temperature to be taken into consideration, exactly so much of the propellent gas can escape that in both cases the same starting velocity of the projectile or shell is realized. In order to be able to adjust accurately the annular nozzle cross section in a simple manner, a temperature scale is again provided at the cover **15** which indicates in connection with an indicator mark (not shown) and provided, for example, at the threaded stud **14** the prevailing conditions under which the firing takes place.

The annular nozzle constituted by the threaded stud **14** and the cover **15** is not subject to corrosion by the hot propellent gases since the heat is conducted away over a relatively large surface. At the outer circumference of the nozzle cross section, which increases in width with increasing diameter, the propellent gases are conducted into the atmosphere by way of apertures, bores or the like **8**, arranged in a larger number in the cover **15**, whereby the deflection effected by the shape of the cover **15** illustrated in the drawing of the propellent gases escaping or outflowing in the direction of the arrows **13** neutralizes the momentum produced by these propellent gases.

While we have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to a person skilled in the art and we therefore do not wish to be limited to the details shown and described herein, but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

We claim:

1. A device for influencing the pressure of propellent charge gases for projectiles to be fired out of a barrel comprising: a barrel having a projectile guiding bore with an axis

means forming a first pressure space for the propellent charge gases,

means forming an auxiliary pressure space means,

second means operatively connected with said first pressure space to release an adjustable quantity of the propellent charge gases including first aperture means providing a communication between said auxiliary pressure space means and said first pressure space and further aperture means providing a communication between said auxiliary pressure space means and the atmosphere, and

adjusting means for adjusting the quantity of said gases released including first means for adjusting the flow cross section of said further aperture means and second means for adjusting the volume of said auxiliary pressure space means.

2. A device for influencing the pressure of propellent charge gases according to claim **1**, including means operatively coupling together said first and second adjusting means.

3. A control device for influencing the pressure of propellent charge gases for projectiles to be fired out of a barrel comprising:

a barrel having a projectile guiding bore with an axis,

first means forming a pressure space for the propellent charge gases, and

means including aperture means in communication with said pressure space for releasing an adjustable quantity of the propellent charge gases to compensate for the temperature variations in the propellent charge, and

further means adjustably secured to said barrel for adjusting the flow cross section of said aperture means, including indicator means for directly indicating the temperature of the propellent charge corresponding to a respective adjustment.

4. A projectile firing device adjustable to produce a fixed predetermined projectile starting velocity and effective propellent pressure over a wide range of firing temperatures without changing the type and characteristics of the shells to be fired, comprising: a barrel having a projectile guiding bore with an axis; wall means radially outward of said bore forming an auxiliary pressure chamber; first passage means providing gas communication between the interior of said bore and said auxiliary pressure chamber; first control means for adjusting the effective volume of said auxiliary chamber to selectively vary the effective propellent pressure within said bore and thus the projectile starting velocity; gas throttling passage means forming substantially the sole gas communication between said auxiliary chamber and the atmosphere; second control means for adjusting the effective throttling of said gas throttling passage means to selectively vary the effective propellent pressure within said bore and thus the projectile starting velocity.

5. The device of claim **4**, wherein said first and second control means are mechanically drivingly interconnected for simultaneous adjustment and include common indicator means for correlating the adjustments with the firing temperature to produce a constant firing velocity and effective propellent pressure when the firing temperature is set for each firing.

6. The device of claim **5**, wherein said wall means consist essentially of the exterior of said barrel, an annular flange concentric with said axis and integral with said barrel, and an annular housing concentrically disposed on said barrel and telescopically sealingly engaging the exterior periphery of said annular flange; said first control means being constituted by a threaded axially adjustable connection between said barrel and said annular housing; said second control means being constituted by a plurality of bores through said annular housing spaced in the axial direction to be sequentially opened and closed by said annular flange during threaded adjustment of said annular housing in one axial direction and the other axial direction, respectively.

7. The device of claim **5**, wherein said wall means consist essentially of the exterior of said barrel, an annular flange having an axis of symmetry transverse to said axis and integral with said barrel, and an annular housing concentrically disposed on said annular flange and telescopically sealingly engaging the exterior periphery of said annular flange; said first control means being constituted by a threaded connection between said annular flange and said annular housing adjustable in the direction of said axis of symmetry; said second control means being constituted by a radially extending, with respect to said axis of symmetry, annular surface on said annular flange and a cooperating opposed generally parallel annular surface on said annular housing mounted for movement toward and away from each other during threaded adjustment of said annular housing in one axial direction and the other axial direction, respectively, discharge apertures fluid connecting the annular space between said annular surfaces with the atmosphere, and an annular deflection lip means generally at right angles to the discharge of said discharge apertures for deflecting and disbursing the discharge propellent gas.

8. The device of claim 5, wherein said wall means consist essentially of the exterior of said barrel, an annular flange integral with said barrel, and an annular housing telescopically sealingly engaging the exterior periphery of said annular flange; said first and second control means each include a common single adjustment thread on said annular housing.

9. The device of claim 5, wherein said wall means consist essentially of the exterior of said barrel, an annular flange integral with said barrel, and an annular housing telescopically sealingly engaging the exterior periphery of said annular flange; said first and second control means each include a common single adjustment thread between said annular housing and said annular flange.

References Cited

UNITED STATES PATENTS

1,549,847	8/1925	Reed	89—1
2,801,416	8/1957	Evans et al.	89—1
3,216,323	11/1965	Wengenroth et al.	89—1.701

FOREIGN PATENTS

954,475	6/1949	France.

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