# United States Patent [19]

**Grimm et al.**

[11] **3,768,362**

[45] **Oct. 30, 1973**


[54] **GUN CONSTRUCTION FOR SEALING BETWEEN A GUN BARREL AND A CARTRIDGE HOLDER**


[75] Inventors: **Oskar Grimm**, Epfendorf; **Ludwig Vorgrimler**, Neckar, both of Germany

[73] Assignee: **Industrie-Werke Karlsruhe Augsburg Aktiengesellschaft**, Postfach, Karlsruhe, Germany



[22] Filed: **July 25, 1972**

[21] Appl. No.: **274,890**

[30] **Foreign Application Priority Data**

Aug. 26, 1971 Germany ..... P 21 42 763.4

[52] **U.S. Cl.** ..... **89/26**

[51] **Int. Cl.** ..... **F41d 7/04**

[58] **Field of Search** ..... 89/13 R, 13 A, 26, 89/33 MC, 155, 156, 157; 42/59–64



[56] **References Cited**

UNITED STATES PATENTS

2,981,023 4/1961 Sergay ..... 89/26



*Primary Examiner*—Stephen C. Bentley

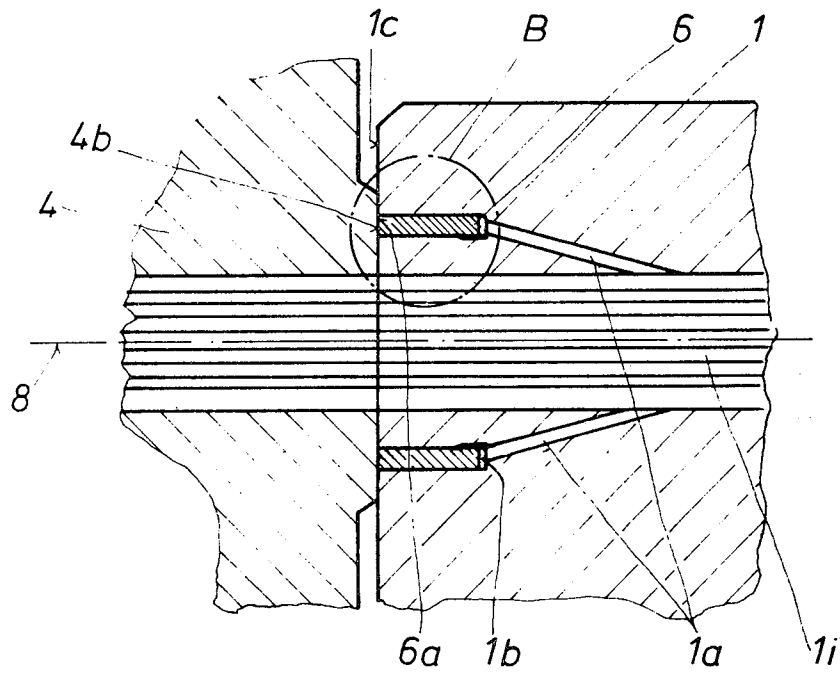
*Attorney*—John J. McGlew et al.



[57] **ABSTRACT**

A gun construction comprises a gun barrel having a projectile bore which is adapted to be aligned with a cartridge holder which may be a rotatable type and which includes an end face which abuts against the inner end face of the barrel. The cartridge holder is provided with an annular groove concentrically arranged around the cartridge receiving bore which carries sealing means, such as a sealing ring, which is ueged against the end face of the gun barrel by high-pressure gases which are generated upon ignition of the cartridge and which are communicated to the groove surrounding the cartridge receiving bore through a passage connected to the cartridge receiving bore and the groove.


**7 Claims, 4 Drawing Figures**



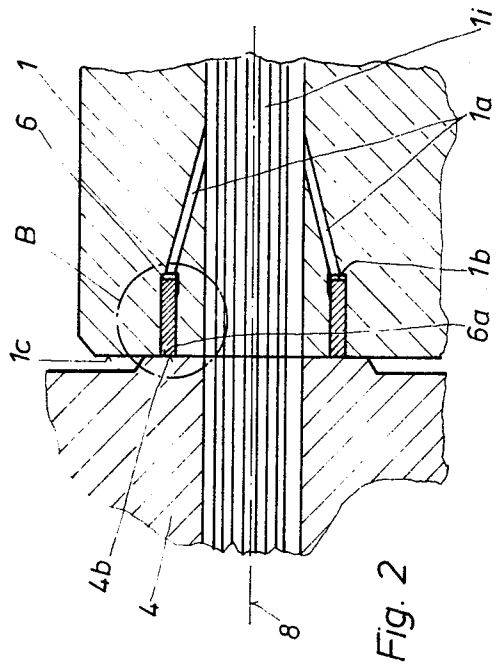



Fig. 2

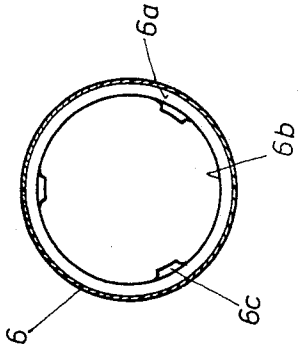



Fig. 4

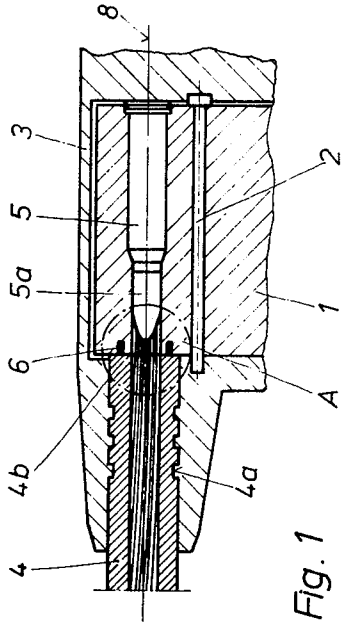



Fig. 1

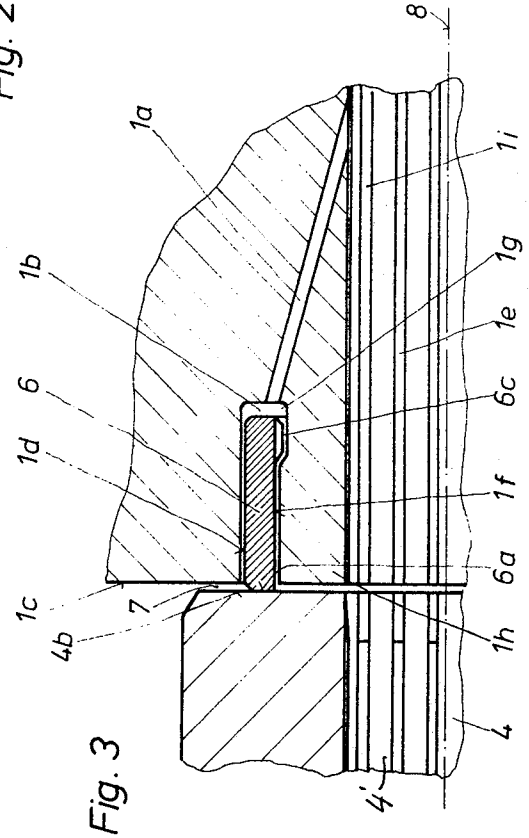



Fig. 3

# GUN CONSTRUCTION FOR SEALING BETWEEN A GUN BARREL AND A CARTRIDGE HOLDER

## BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to the construction of weapons and, in particular, to a new and useful gun construction having improved sealing means between a cartridge receiving holder and the gun barrel.

2. DESCRIPTION OF THE PRIOR ART

The present invention is particularly applicable to guns having rotatable cartridge holders with individual cartridge receiving bores which may be rotated into alignment with the gun barrel bore, and especially weapons of high ballistic power with correspondingly designed ammunition. Automatic rapid fire guns with revolving cartridge holder drums have been known for a long time, for example, some types have been employed as an airplane weapon. One known weapon of this type has a cadence of 1,200 rounds per minute and a velocity of 1,000 m/sec. An advanced model of the known construction has about 1,200 rounds per minute and 535 m/sec. characteristic with a caliber of 30 mm. The characteristic features of these rapid-fire guns is substantially the construction of their revolving cartridge-receiving drums. Such drums are usually provided with a plurality of cartridge-receiving bores or chambers which are distributed around the circumference and which are rotated successively into alignment with the projectile bore of the gun barrel. The movement of the drum is effected by a slide valve which acts on the drum by means of cam guides acting through rollers, etc. A cartridge conveyor star from which the cartridges are moved in steps into the cartridge chambers of the drums is arranged coaxially to the drum and connected with it by a coupling. In these revolving guns, the gas-tight sealing of the separating gap which exists between the cartridge holder drum and rifle barrel is difficult to effect and maintain. The known means for sealing the separating gap are generally in the form of bushes, which are pressed by the pressure of the cartridge surface against the rear surface of the gun barrel, to seal the gap between the drum and the barrel, but they have various disadvantages which impair the efficiency of the gun which is so equipped. For one reason, the sealing means are arranged directly in the gas current and hence in the zone of maximum heating when the projectile leaves the cartridge chamber so that they are necessarily exposed to equally extensive heating by the powder gases. This reduces their life expectancy very greatly. On the other hand, the sealing means of the known design are relatively heavy so that they hammer with great energy against the muzzle during the firing and stress the muzzle greatly. A further disadvantage is that the surface admitted by the powder gases is relatively large so that an equally great counterforce is transmitted to the drum and to the drum housing. As a result, it is necessary to make the drum housing particularly heavy. A further disadvantage is that the sealing means must be locked in the drum by pricking or calking. This is not only cumbersome, but it reduces the actually usable sealing area due to the chamfer or bevel required on the sealing ring.

Other disadvantages of the known constructions is the poor guidance of the projectile from the cartridge holder to the gun barrel because the rotating cartridge holder has no firm guidance in the range of the sealing bushing which may be employed. A further disadvantage is that the outer gap between the sealing element and its bearing in the drum cannot be completely sealed, so that gas losses occur and this has a negative effect on the muzzle velocity and reduces the life expectancy of the weapon parts.



## SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a structurally and functionally simple and safe sealing system for a weapon which ensures its long life and which can be easily taken apart and used without special tools or assembly devices and be reassembled again. With the invention, the end face of the cartridge holder or cartridge drum which faces the gun barrel is provided with an annular groove arranged concentrically with the projectile receiving bore or guide. A high-temperature elastic sealing means in the form of a ring is placed in the annular groove and the groove is connected with the cartridge receiving bore of the holder through a plurality of bores which are distributed over the circumference of the drum. The high pressure powder gases which are produced during firing, therefore, act through the connecting passages on the sealing ring in a direction to urge the ring outwardly into sealing engagement with the gun barrel to seal the area around the cartridge-receiving bore and the gun barrel bore. The ring is constructed so that the high-pressure gases generated by the firing of the projectile seal the side of the ring with respect to the wall of the groove on its one side and supported with regard to the groove on the opposite side.

The sealing means for the gun is an essential feature of the invention and it comprises a sealing ring with a relatively narrow ring surface which is preferably made of a hard metal with a relatively great expansion characteristic of about 7%. The ring is provided with noses or projections at its inner end which engage into extensions of the groove and the thickness of the noses is less than the sum of the radial clearance of the outside and inside of the sealing ring itself. The engagement of the noses in the groove ensures that the the natural elasticity of the ring ensures its fixation in position.

A further feature of the invention is the construction of communicating bores which connect the inner end of sealing grooves with the cartridge receiving bores of a cartridge holder and which are distributed over the circumference of a cartridge drum and extend obliquely to the bore axis of the projectile guide bores of the cartridge holder and of the gun barrel bore and which open into the cartridge-receiving chamber of the gun holder substantially at the level of the projectile guide.

The invention provides a number of advantages:

First of all, an optimum seal is achieved between the end of the gun barrel and the drum without any special structural or constructional expenditures, since the sealing is effected by a sealing ring which is set in motion by the gas pressure and is temporarily deformed within relatively wide limits by corresponding selection of the material.

The arrangement of the bores distributed around the circumference of the gun holder at a relatively inclined position to the bore axis provides a further advantageous construction. Partial currents of the highly expanded powder gases, produced during the firing, flow through the bores and act abruptly on the sealing ring.

This ensures that the separating gap between the end of the barrel and the drum is maintained in a sealed gas-tight condition by the axial biasing of the rings against the gun barrel end wall by the high pressure gases. The gas currents produced by the ignition of the cartridge also effect a temporary deformation of the sealing ring which bears tightly on one side of the annular groove while it supports the ring at the other side. The arrangement of the communicating bores between the groove and the cartridge-receiving bores of the holder is such that the high pressure gases cover a relatively long travel distance until they strike against the sealing ring. This ensures that the sealing ring will be outside of the hot zone formed during the detonation of the propellant charge and this has an extremely beneficial effect on the life expectancy of the device.

Accordingly, it is an object of the invention to provide an improved weapon construction which includes a gun barrel having a projectile bore which is alignable with a cartridge receiving bore of a cartridge and wherein the cartridge receiving bore on the side facing the gun barrel which receives sealing means which bears against the end face of the barrel and which is urged against the end face by the action of the high-pressure gases which are generated upon ignition of the cartridge and which communicate with the sealing groove through passages defined in the holder which connect to the cartridge receiving bores of the holder.

A further object of the invention is to provide a device for sealing a cartridge holder to a gun barrel, and particularly, a cartridge holder which is mounted for revolution in respect to the gun barrel in order to successively present one or more cartridge bores into the alignment with the barrel and which includes means for effecting the sealing under the action of the high-pressure gases which are generated during ignition.

A further object of the invention is to provide a gun construction which is simple in design, rugged in construction, and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the Drawings:

FIG. 1 is a partial longitudinal sectional view of a gun constructed in accordance with the invention;

FIG. 2 is an enlarged partial section view of a portion of the gun shown in FIG. 1 at the location designated by "A";

FIG. 3 is a view similar to FIG. 2 of an enlarged sectional view of the location designated "B" in FIG. 2; and

FIG. 4 is an enlarged end elevational view of the ring shown in FIG. 1.

## GENERAL DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in particular, the invention embodied therein, comprises a weapon or gun which includes a cartridge holder in the form of a revolving drum 1, which is mounted for rotation about an axle 2 which is journalled in the gun housing 3. The gun barrel 4 is supported within the housing 3, for example, by means of a bayonet joint. The drum 1 has a plurality of cartridge-receiving bores or cartridge chambers, for receiving a cartridge 5, and they may be successively aligned with the bore 4' of the gun barrel 4. When the cartridge 5 is fired or detonated, its projectile 5a is propelled forwardly to the bore 4' of the barrel 4.

In accordance with the invention, there is provided a sealing arrangement for sealing the cartridge holder 1 with the gun barrel 4, and for this purpose, sealing means in the form of a sealing ring 6 is carried in a groove 1*b* of the drum which is an annular groove which extends around each of the cartridge-receiving bores 1*i*. In accordance with a feature of the invention, the drum 1 contains an obliquely extending passage 1a which is disposed at an angle to the axis of the cartridge receiving bore 1i and which forms a communication between the cartridge receiving bore and the inner end of the groove 1b. During ignition, the sealing ring 6 is driven forward by the high-pressure gases which are developed and which move through the passage to the rear end of the groove 1b and bear against the sealing ring 6 to urge it against the end face 4b of the gun barrel inner end wall. The ring 6 thus seals the separating gap 7, as shown in FIG. 3, between the gun barrel 4 and the end face of the drum 1 against the powder gases.

As indicated particularly in FIG. 2, the sealing ring 6 has only a relatively narrow bearing surface 6*a* and this need not be any larger than necessary for its function as a sealing element. Practical firing tests have shown that a narrow ring surface is completely sufficient even with a high cadence, since the surface pressure is relatively high, and a narrow ring can naturally adapt itself better to the unevenness of the opposite surface 4*b* than a heavy and correspondingly rigid sealing bush. A low weight sealing ring can also be accelerated much faster during the buildup of the gas pressures in the cartridge chambers.

The sealing ring 6 is admitted by partial gas curents of the high pressure powder gases which are separated from the total gas current and flow through the communicating passages 1*a*. The partial currents reach the individual grooves 1b through individual, or several, small bores 1*a* which are distributed over the circumference of the drum 1. The gases press the sealing ring 6 with its bearing surface 6a against the end wall 4*b* of the barrel 4. The counterforce acting on the rear side of the annular groove 1*b*, which must be absorbed by the gun housing 3, in addition to the bottom pressure of the cartridge 5, has only a relatively low value since this additional pressure which acts in the annular groove 1*b* is lower because of the throttling effect of the communicating bores 1a than the gas pressures in the cartridge chamber itself. The surface of the sealing ring 6 is very small and thus, the pressure times the area results only in a small additional force which loads the housing 3. This has the advantage that the housing can be made much lighter than those of conventional design.

One function of the sealing ring 6 is to trap powder gases that try to issue radially into the separating gap 7 between the end wall 4*b* and the end face 1*c* of the drum. In addition, the ring also ensures that the gases do not issue between the sealing ring and the outer wall of the annular groove which contains it. In this sealing action, the elastic deformability of the material of the

sealing ring is employed. As soon as the projectile 5a passes through the space during the firing, the powder gases have an expanding effect to close the outer annular gap 1*d* and the inner annular gap 1f which the ring 6 makes with its associated sealing groove 1*b*. The elastic deformation of the drum 1 only sets in when the sealing 6 already bears tightly on the end wall 4*b* of the gun barrel 4. This is because partial currents of the powder gases, which are separated from the total gas current, have already arrived in the annular groove 1*b* through the bores 1*a* to move the sealing ring into sealing engagement with the end face of the barrel. The construction is such that it is impossible for the sealing ring to bear prematurely against the walls 1*d* and 1*f* of the groove and to hinder the ring in its necessary movement to effect the sealing of the surface 4*b*. The ring acts to seal first the separating gap 7 and then the gaps 1*d* and 1*f* in chronological order and this is enhanced by the fact that the bores 1*a* are arranged in a relatively inclined position to the bore axis 8 of the projectile guide 1e and the gun bore 4'. The communicating bores 1*a* open into the projectile guide 1e substantially at the level of the cartridge 5.

The mounting of the sealing ring 6 can be effected very simply and rapidly. No security against rotation is required. This is because as shown in FIG. 4, several circumferentially distributed noses 6c are arranged on the inside end 6b of the sealing ring 6. These noses are shown with greatly increased radial dimensions in order to be apparent in the drawings. In the assembled state, they engage in the recess portions 1g at the inner end of the sealing bores 1*b* and they prevent the sealing ring from falling out in the assembled state. If the noses 6c are so dimensioned that the radial measure of the sealing ring 6 measured over these noses is slightly under the radial measured width of the annular groove 1*b*, the sealing ring 6 assumes at first a polygon form when inserted into the annular groove 1g due to its elastic deformability. When the noses 6c have entered the relief recesses 1*g*, the sealing ring 6 snaps back into its original circular form in which it remains.

Particularly suitable as a material for the sealing ring 6 is a hard metal with great extensibility. An example is a metal known under the tradenames STELLITE or ALACRITE, particularly since hard metals of this type also have the positive and even desired property of high temperature strength.

Due to the manner of securing the ring, it is possible to keep the mass of the sealing ring very small since its bearing surface 6*a* corresponds approximately to the cross-section of the ring 6. With this design, no chamfer or bevel is required for overlapping the pricking or calking which heretofore required an increase of the cross-section behind the sealing surface 6a. In addition, to effect a calking of the hardened drum 1 is not simple because the hard and brittle surface of the drum 1 must be deformed and there is a risk that particles of material will break out. This difficulty is increased when a sealing ring 6 which has become unusable because of wear, for example, must be replaced by a new one, since the securing would have to be effected again by calking.

The sealing system according to the invention has a particularly favorable effect on the firing precision of the gun since the guidance of the projectile 5*a* from the cartridge chamber to the gun barrel 4 need not be interrupted. It can be seen in FIGS. 1 to 3 that the projectile 5*a* has to bridge over the gap 7 between the drum 1 and the end wall 4*b* of the barrel 4 on its way into the barrel and this is unavoidable in any revolving gun due to its design. This gap is only a fraction of a millimeter even in large caliber revolving guns. Particularly, if the projectile guide 1e of the drum 1 is provided with guide bars or grooves in the cartridge bore 1*i*, into which the rotating band of the projectile 5*a* can cut, a good guidance of the projectile from the cartridge chamber into the barrel is achieved. In the known constructions, the tendencies of the projectile to cant or slant is increased because of the ring slot which interrupts the guidance of the projectile but this is not so with the inventive construction.

While a specific embodiment of the invention has been shown and described in detail to illustrate the the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A weapon construction, comprising a gun barrel having a projectile bore and terminating in an inner end face surrounding the bore, a cartridge holder having a cartridge receiving bore with a projectile guide bore portion alignable with the gun barrel projectile bore, said cartridge holder having an end wall engageable against the end wall of the gun barrel and having an annular sealing groove spaced outwardly from the projectile guide bore portion of said cartridge holder, elastic sealing means in the sealing groove, and at least one high-pressure powder gas passage communicating said cartridge receiving bore with the interior of said sealing groove at a location to urge the sealing means to engage against the gun barrel end wall and to seal the area around the cartridge receiving bore and the gun barrel projectile bore.

2. A weapon construction, according to claim 1, including a gun housing supporting the gun barrel, said cartridge holder being rotatably mounted in said gun barrel and having a plurality of cartridge receiving bores distributed around its circumference which are selectively alignable with the gun barrel projectile bore, said sealing means comprising a sealing ring having a relatively narrow ring surface.

3. A weapon construction, according to claim 2, wherein said sealing ring comprises a hard metal having an expansion of about delta = 7 percent.

4. A weapon construction, according to claim 1, wherein the sealing groove includes an interior recess, said sealing means comprising a ring having a nose engaged in the recess of the sealing groove and fixing the sealing ring in the cartridge holder.

5. A weapon construction, according to claim 1, wherein said sealing means comprises a sealing ring having an inner clearance with the wall of the groove and an outer clearance with the wall of the groove, said groove having an interior relieved portion at its inner end, said ring having a nose extending into the relieved portion and having a radial clearance with the wall of the relieved portion which is slightly less than the sum of the radial clearances on the inside and the outside of the sealing ring.

6. A weapon construction, according to claim 1, wherein the high-pressure gas passage comprises an obliquely extending bore communicating between the inner end of said groove and the cartridge receiving bore of said holder.

7. A weapon construction, according to claim 1, wherein said cartridge holder is provided with bores having a guide formation for the guidance of the cartridge projectile.

* * * * *