T. H. EICKHOFF.

BREECH CLOSURE FOR GUNS.

APPLICATION FILED OCT. 7, 1920.

1,406,546. Patented Feb. 14, 1922.

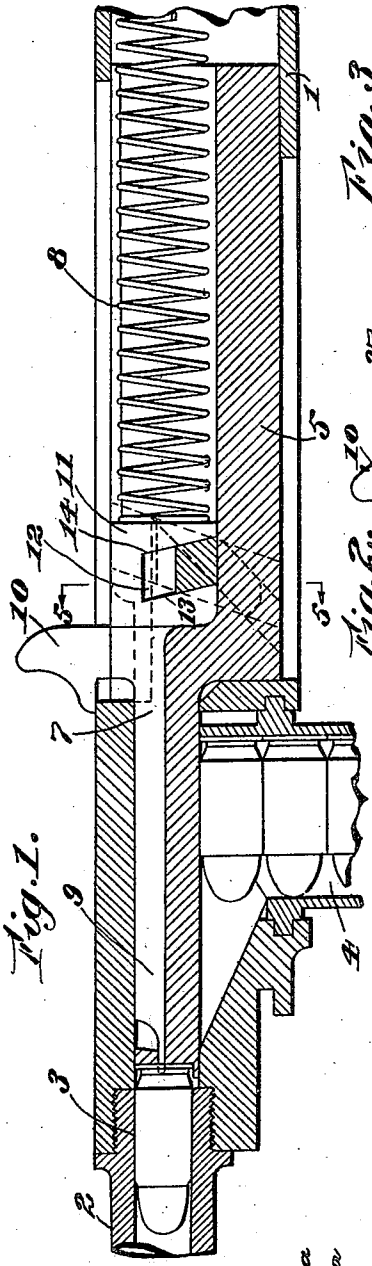

Fig. 1.

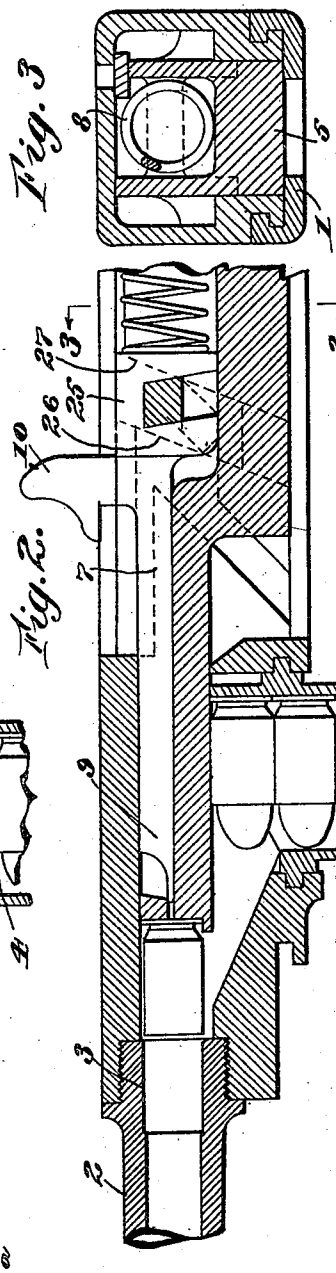

Fig. 2.

Fig. 3.

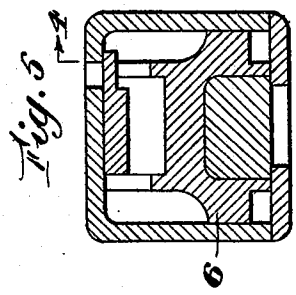

Fig. 5.

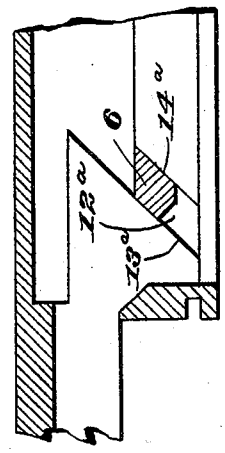

Fig. 4.

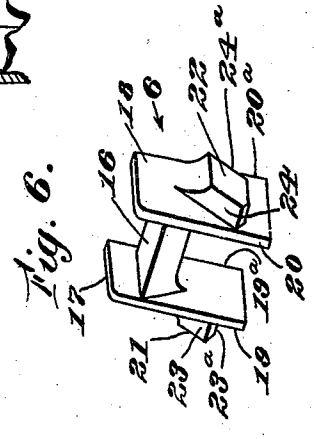

Fig. 6.

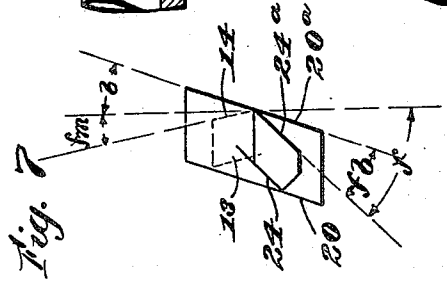

Fig. 7.

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UNITED STATES PATENT OFFICE.

THEODORE H. EICKHOFF, OF CLEVELAND, OHIO, ASSIGNOR TO AUTO-ORDNANCE CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

BREECH CLOSURE FOR GUNS.

1,406,546. Specification of Letters Patent. Patented Feb. 14, 1922.

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To all whom it may concern:

Be it known that I, THEODORE H. EICKHOFF, citizen of the United States of America, and resident of Cleveland, in the county of Cuyahoga and State of Ohio, have invented new and useful Improvements in Breech Closures for Guns, of which the following is a specification.

This invention relates to breech closures for firearms, of the general class in which there are two members, mutually abutting against each other when in breech closing position, with their opposed and contacting surfaces disposed at an angle to the line of breech pressure produced by the detonation of the explosive in the firearm, and which, as the breech closure opens, slide relatively to each other upon said inclined surfaces. In particular, the present invention is addressed to and adapted to be used in breech closures which operate substantially in accordance with the principle disclosed and exemplified in John Blish's United States Letters Patent, No. 1,131,319, dated March 9, 1915, in which the inclined surfaced and abutting members are so proportioned in respect to the angle which their inclined surfaces present to the applied breech pressure that the members lock together at initial and high breech pressure, and upon the subsidence of that pressure to a critical lower value, slide with relation to each other to open the breech of the firearm. The invention in its broader aspects however would also be applicable to breech closures of other types in which high breech pressures are transmitted through abutting surfaces of limited area.

As pointed out in the patent to Blish, the action of the cooperating parts of the breech closure locking members under the high pressures of discharge is not in accordance with the ordinarily accepted laws of friction. One theory of explanation of the abnormal action of the parts when subjected to such high pressures is based on the well-known fact that all solid substances have tenaciously clinging to their surfaces a layer of condensed gas. Such condensed gas constitutes a very thin film which may perhaps be of the order of thickness of the orbit of a single molecule of such gas, and it is a matter of common knowledge that it is exceedingly difficult to remove such film of gas from the surface of a metal, there being apparently an actual cohesion between the metal and the gas. Under ordinary conditions of pressure and in circumstances under which the usual laws of friction apply, it appears reasonable to suppose that the films of condensed gas interposed between the surfaces of adjacent metallic elements serve in a sense as a sort of lubricant in preventing actual physical molecular contact of the metallic surfaces. When however, such surfaces are subjected to pressure above a certain critical value, it may be possible that the molecules of gas lying between such surfaces are occluded within the substance of the metallic elements, in which case the molecules of the metallic elements may be considered to come into actual physical contact and to be subjected to the laws of molecular attraction. Under these circumstances it would appear to be a reasonable supposition that the cohesive force tending to hold the elements in contact, together with the absence of the lubricating gas film, is more than sufficient to overcome any component of the applied force tending to cause sliding of one of such elements over the other. Upon release however, of the applied pressure, when the critical point is again reached, the occluded molecules of gas may be regarded as ejected from the metallic mass of the elements, thus serving to break molecular contact of the latter and again act as a lubricant therebetween, whereupon the ordinary laws of friction supervene.

Whether or not the structure of the Blish patent operates in accordance with the above theory or whether or not the breech closure of the present invention operates according to the discovery disclosed as aforesaid in said patent to Blish, provided it comprises inclined surfaced members which are pressed together when breech pressure is developed, the said members have to sustain a very considerable pressure load at and over their surfaces which are in actual contact. This breech pressure is substantially equal to the ballistic pressure serving to propel the projectile from the gun and may be of the order of 50,000 pounds to the square inch, more or less. The magnitude of this pressure per unit of actually contracting area depends on

a function of the total contacting area, and the object, or one of the objects of this invention is to secure a maximum area of actual contact between two such operating members of a breech closure mechanism.

By accomplishing this object, the sustained load will be distributed over the largest available extent of opposed faces, concentration of load at points or portions of such faces with crushing and disintegration of the same will be avoided, the interacting members will endure a maximum of service, and in the particular case of a firearm operating according to the discovery patented by John Blish, the initial locking of the breech closing members will be made more certain and secure, while the release and relative movement of those members will be effected with certainty at the critical diminished pressure.

No matter how carefully and accurately the contacting surfaces of the inclined-abutment breech closure members may be machined and ground, they are never strictly or microscopically smooth. As the edges of the keenest razor discloses marked serrations under the microscope, so also the faces of smoothly-ground metal pieces are characterized by irregularities of contour, albeit of microscopic dimensions.

When, as has invariably been the case, the inclined-abutment members of a breech closure are made of steel, treated so as to assume hardness in high degree, the material at their opposed surfaces or faces stubbornly resists all effort tending to distort or modify them even momentarily. Such surfaces are characterized by microscopic irregularities, and though it may seem that the surfaces come into uniformly close contact over their entire opposed areas, in fact they bear against each other only at the peaks and heights of their faces and it is on these salient portions that the imposed load is concentrated. Microscopic examination of the edge of a piece of steel, surfaced and treated as would be the case with a steel inclined-abutment member of a breech closure, has made it apparent that the steel-to-steel contact of two such members, under breech-pressure load, can not extend over more than fifty per cent of the total area of the opposed faces, even when account is taken of the slight compressibility of steel.

It is of course practically impossible that the faces of two such opposed steel members should even by chance fit each other microscopically and thus bring into action the entire area of the faces, to resist and distribute imposed pressure-load. The intensity of pressure, when borne by salient points of contact, may be imagined, though it can not be accurately calculated, and the destructive effect of such locally concentrated pressure loads, is readily comprehended. If it be suggested that the mutually abrasive action of the coacting members themselves may correct the above described condition, let it be borne in mind that the metal presenting the face to be abraded is composed of interlaced crystals, and that the destruction of a salient crystal merely transfers the salience to its neighbors, and that, after the two members in contact have smoothed each other as evenly as their mutual abrasion can effect, the faces remain characterized by microscopic undulations of contour and will so persist. Moreover the crushing and disintegration of such salient portions of the surface under the extreme overload imposed thereon serves to provide detached microscopic particles of hard material which serve as active abrasive media causing a rapid scoring of the surfaces as they slide one on the other.

As a result of the phenomena above referred to the locking abutments of high pressure guns, and indeed of relatively low pressure guns such as those firing .45 calibre pistol cartridges, frequently break during the first few rounds fired during the breaking in process; but according to this invention the breaking in process is rendered unnecessary and there is apparently no greater liability to breakage during the first rounds than later.

For accomplishing the above mentioned object, a breech closure is provided having two abutment members, the face of one of which, on imposition of breech pressure load, may become the contour-negative, or matrix, of the other, so the load is distributed over practically the entire area of the opposing faces. The means for so securing load-distribution lies in the selection of material for the face of one of said members which is more yielding than that of the other and is at the same time resilient. Specifically, the best results which have been obtained have been with two such members, one of which is composed of hardened steel, the other of an alloy having the approximate composition of copper 89%, aluminum 10%, iron 1%. When the faces of two members, one of steel, the other of alloy, both machined and ground as smooth as possible, are pressed together and sustain a load comparable to that produced on breech closure members under breech pressure, the steel face by reason of the relatively great rigidity of its material retains its microscopically undulated contour substantially unaltered, whereas the alloy face takes the impress of the steel face. The softer face, while the pressure load is sustained, is a matrix of the other. Doubtless there are higher local concentrations of pressure at the salient portions of the steel face than in the hollows between, but the general effect of the assumption by the alloy face of a contour which is

the negative of that of the steel face, is to distribute the pressure and relieve the concentrations which have characterized the steel-to-steel opposition of similar members as heretofore made. When thus arranged there is no tendency to crush and disintegrate the salient points of either of the contacting elements as those of the steel simply sink into the substance of the opposing member, while such points of the latter as contact with the steel face are merely depressed due to the superior malleability and softness of the material employed. Thus the formation of detached abrasive particles is eliminated and the destructive scoring and wear commonly due to the presence of such particles is avoided.

A material of the general type of that above indicated, having a modulus of elasticity much lower than that of the hardened steel with which it contacts, tends to yield readily to the passage of such irregularities as the surface of the steel may present when the parts are moved relatively as in sliding one on the other, but upon passage of such irregularities such material tends quickly to assume its original form. Thus while the opposed surfaces may not be mathematically plane, the high resilience of one as respects the other, as well as the extreme resistance which a material of the class described presents to the action of oft-repeated stresses, enables the abutting elements to undergo long periods of service without appreciable wear.

In breech closures which operate according to the Blish specifications above mentioned, the momentary mutual matrix relationship of the locking members, when composed of materials of different rigidities confirms the locking action at high breech pressures.

In the usual practice of forming gun locks of the class to which this invention appertains, it is common to harden both the steel lock and the parts cooperating therewith and then to assemble the parts in proper operative relationship. When heat treated steel is thus employed for all of the parts, it is very difficult to secure an accurate fit, as the heated treatment subsequent to machining introduces slight inaccuracies which can only be overcome by a slow and laborious process of lapping with fine abrasive and "breaking in" by the repeated operation of the assembled parts. A further object of the present invention is to facilitate the fitting and assembling of the breech lock and its associated parts. The employment of a relatively soft but strong alloy such as above referred to or a substance having similar physical properties as a material for one of the cooperating elements, provides one mode of accomplishing this latter object, it being found, particularly when the locking member is formed of such material, that it readily accommodates itself to the inaccuracies in adjacent parts, thus avoiding much expenditure of time and labor and rendering the locks more truly interchangeable.

With the foregoing explanation of the principle on which the invention operates, the illustrative example shown in the drawings hereto annexed will be readily understood.

In these drawings,

Fig. 1 is a longitudinal cross-section of so much of a gun embodying the present invention as is necessary to disclose its mode of application thereto, the parts being shown in firing position;

Fig. 2 is a view similar to Fig. 1 showing the parts in the position which they occupy immediately after firing and unlocking of the breech lock;

Fig. 3 is a transverse or cross section on the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary longitudinal section on the line 4—4 of Fig. 5;

Figure 5 is a transverse section on the line 5—5 of Fig. 1;

Fig. 6 is a perspective view of the locking element employed in accordance with this invention; and

Fig. 7 is a diagrammatic view illustrating the annular relation of certain of the parts employed.

The device forming the subject matter of this application constitutes an improvement in the mechanism disclosed in the application of Oscar V. Payne, Ser. No. 282,642, filed March 14, 1919, to which application reference may be had for a more complete disclosure of the particular gun chosen for the purpose of illustrating the present invention.

1 is a receiver upon which the various operative parts are supported and which is hereinafter referred to as the frame or frame member. 2 is the gun barrel having a firing chamber 3, the gun being provided with a magazine 4. 5 is the breech-block slidably mounted in the frame to move toward and from the firing chamber. 6 is a breech lock for retaining the breech-block in firing position, and 7 is a firing member longitudinally slidable upon the breech-block and toward and from the firing chamber. 8 is an actuating spring serving normally to move the breech-block into closed position and also as the operating means for the firing member. The firing member 7 comprises a forwardly extending portion 9 preferably guided in a suitable slot in the forward part of the breech-block and is furnished with a finger piece 10 by means of which the firing member may be manually retracted. The firing member is also provided with a rear portion 11 slidably

guided in a longitudinal cavity or channel in the upper rear portion of the breech-block. Within this cavity is also mounted the spring 8.

The rear portion 11 of the firing member is provided with a downwardly and rearwardly inclined slot 12 having a forward wall 13 and a rear wall 14. When in firing position the lower edges of the walls 13—14 intersect the walls 13^a—14^a respectively of a pair of forwardly and downwardly inclined slots in the side walls of the frame or receiver, of which one is indicated at 12^a Fig. 4, formed in the frame member 1 at opposite sides of the breech-block 5.

The locking member 6, shown in perspective in Fig. 6, comprises a horizontal bar 16 serving to connect a pair of spaced members 17—18 lying in parallel vertical planes. The forward and rear edges of the members 17—18 form inclined surfaces 19—19^a—20—20^a respectively, and the front and rear surfaces of the member 16 are also inclined, but downwardly and rearwardly, the inclination of the latter surfaces corresponding to that of the surfaces 13—14 of the firing member with which they are arranged to engage. Upon the outer surfaces of the members 17—18 respectively are provided outstanding lugs 21—22 which have forwardly and downwardly inclined surfaces 23—23^a—24—24^a respectively. The inclination of the surfaces 23—23^a and 24—24^a is substantially that of the walls 13^a 14^a of the slots 12^a in the frame, such surfaces being adapted to slidably engage said walls.

The breech-block 5 at opposite sides of the cavity within which the spring 8 is seated is provided with upstanding walls having forwardly and downwardly inclined slots 25 therein, such slots having forwardly and downwardly inclined front and rear walls 26—27. The inclination of the walls 26—27 corresponds to that of the surfaces 19—19^a, 20—20^a on the locking member with which such surfaces have sliding engagement.

Referring to Fig. 7, the angle fb, which is the difference between the angle f of the lock-frame surfaces and the angle b of the lock-block surfaces, is the effective angle for restraining the breech-block in closed position upon firing. If the breech closure is to operate on the Blish principle, this angle should be almost equal to the angle of repose for the particular materials and pressures employed. The firing pin angle is designated as a negative angle inasmuch as it slopes in a direction opposite to the other angles. The angle fm of the firing pin may be varied considerably, but should not be made so large as to cause undue friction between the firing member and the locking bolt nor should it be made too small inasmuch as in the latter case the firing member would not be projected forwardly relatively to the breech-block with sufficient momentum to fire the cartridge.

The frame 1 with its guiding surfaces 13^a—14^a is formed of steel and after machining is preferably subjected to a cyaniding process to secure the necessary hardness in the wearing surfaces. The breech-block with its surfaces 26—27 may also be formed of the same material and heat-treated in a similar manner. The lock 6 however, is formed of a material relatively softer and more malleable than such heat-treated steel, and of a character such that when subjected to exceedingly high pressures such as those generated in the firing chamber of the gun, the lock 6 will accommodate itself to the microscopic irregularities in the guiding surfaces of the relatively harder frame and breech-block, receiving an impress thereof in its surface and thus in effect becoming a contour-negative or matrix of such harder elements. While it is contemplated that many materials may be found which would fulfill the necessary requirements, experiment has shown that a copper alloy having the approximate composition of copper 89%, aluminum 10% and iron 1% is especially well adapted to this use. The ratio of hardness of such an alloy to the heat treated steel may be approximately as one to four while at the same time providing the necessary compressive strength to enable the lock to perform its functions in a satisfactory and serviceable manner.

The modulus of elasticity of such an alloy being small as compared to that of steel, the locking member readily yields to the projections on the surfaces of the parts cooperating therewith, but by reason of its great resiliency and ability to withstand repeated stresses without deterioration, the bolt receives no appreciable parmanent injury from the dragging of such projections thereover. Thus by the employment of a lock of relatively soft material such as above indicated the effects of abrasion between the lock and its cooperating parts is almost entirely eliminated. This effect is probably due in part also to the fact that there is no crushing and breaking down of the meeting surfaces such as apparently occurs when a steel-on-steel contact is employed, and thus no production of minute detached particles of hard metal which would if present rapidly score and abrade the contacting faces of the parts.

While as hereinabove specifically described, the locking member has been designated as being of the softer material, it is to be understood that many, if not all of the advantages occuring from the employment of such a material may be secured by making the locking member of heat-treated steel or other hard material and utilizing the softer material in the productions of all,

or of such parts only if preferred, of the breech-block and receiver as cooperatively engage the locking member.

In applying the invention to guns in which an abutment on the breech-closure abuts directly against an abutment on the receiver, instead of through the medium of a locking member such as 6, either the breech closure abutment or the receiver abutment is made of the softer material.

I claim:

1. In a gun, abutment mechanism for opposing the explosion reactions comprising a pair of pressure receiving elements relatively movable under breech pressure and having mutually engaging surfaces, the surfaces of the respective elements being of such a relative degree of hardness as to permit irregularities of one to be impressed in the other.

2. In a gun, abutment mechanism for opposing the explosion reactions comprising a pair of pressure receiving elements relatively movable under breech pressure, said elements having such different degrees of hardness as to permit adjacent surfaces thereof to be brought substantially into uniform molecular contact under the imposition of such high pressure.

3. In a gun, abutment mechanism for opposing the explosion reactions comprising a plurality of pressure receiving elements relatively movable under breech pressure, said elements having opposed surfaces and being constructed of materials having different degrees of hardness to permit physical contact of said surfaces throughout substantially the entire area thereof upon imposition of such pressure.

4. In a gun, abutment mechanism for opposing the explosion reactions comprising a pair of relatively movable pressure receiving elements having engaging surfaces, one of said elements being movable in a path inclined to the direction of applied pressure, the engaging surface of one of said elements being of a material having a substantially lower modulus of elasticity than the material of the cooperating surface of the other element.

5. In a gun, mechanism for opposing pressures of the order of 50,000 pounds per square inch, a pair of elements relatively movable under breech pressure having opposed pressure transmitting faces, the face of one of said elements being of a degree of hardness substantially different from that of the other face.

6. In a lock mechanism for guns, a movable locking element and an abutment element therefor, one of said elements being of a hardened ferrous material and the other thereof comprising a material having a Brinell hardness number of approximately one fourth that of such ferrous material.

7. In combination in a gun, a movable locking element and an abutment element therefor, said elements being relatively movable under breech pressure, one of said elements being of heat treated steel and the other thereof being of a copper alloy.

8. In a locking machanism for guns, in combination a pair of engaging abutment elements relatively movable under breech pressure, one of said elements being of a hardened ferrous alloy, and the other thereof being of a material relatively malleable as respects such alloy.

9. In a gun, abutment mechanism for opposing the explosion reactions comprising a breech block and a lock member movable relatively to each other under breech pressure, said breech block having a hardened steel surface abutting against said member transversely of the line of breech pressure and said member being of a copper alloy.

10. In a gun in combination a breech block, a lock member movable relatively thereto, said breech block having a hardened steel surface for supporting said member against the breech pressure and said member being of a copper aluminum alloy.

11. In a gun, a fixed abutment and breech closing mechanism having a part movable into and out of position in front of said abutment, said part being formed of a copper alloy and being movable out of position by breech pressure.

12. In a gun of the class described, a relatively fixed member having an abutment element therein, a breech block slidable with respect to said fixed member, and a lock member engageable with said abutment element and contacting with said breech block, said lock member being of a material relatively soft as compared with the material of the breech block and the abutment.

13. In a gun, a frame member having an inclined guide slot, a breech block slidable relatively to said frame member and provided with an inclined guide slot, and a locking bolt of a copper alloy mounted for sliding movement within the said slots.

14. In a breech lock mechanism for guns, in combination, a locking member movable under breech pressure, and an abutment member supporting said locking member against breech pressure, one of said members being of hardened steel and the other of said members being of a softer material capable of receiving an impress of the microscopic irregularities of the co-operating surface of the other under the action of ballistic pressures.

15. In a breech locking mechanism of the Blish type, relatively movable members for opposing the ballistic pressures of discharge, one of said members being of a relatively softer material than the other whereby greater endurance under repeated stress

and better contact of the members is achieved.

16. In a breech locking mechanism of the Blish type, a pair of pressure receiving elements having engaging surfaces inclined to the direction of breech pressure, said elements having such different degrees of hardness respectively that pressure applied to one of said elements is transmitted to the other thereof and distributed in a substantially uniform manner over the entire area of the contacting surfaces of said elements.

17. A firearm comprising a frame, a breech block, a locking member having surfaces constructed and arranged for engagement with abutment elements of the frame and breech block respectively, said elements being inclined to the direction of breech pressure and of relatively greater hardness than the surfaces of said locking member with which they engage.

18. In a breech locking mechanism of the Blish type, a frame, a breech block slidable thereon, said block having an abutment element inclined to its path of movement, and a locking member engaging said abutment element and an inclined abutment element of the frame, said locking member being of a material such as a copper-aluminum alloy whereby under the action of high ballistic pressure it is forced into actual physical contact with substantially the entire area of the cooperating surfaces of said abutments.

19. In a breech locking mechanism, in combination a frame, a breech block slidable relatively thereto, said frame and said block having abutment surfaces inclined to the direction of breech pressure and of the order of hardness of heat treated steel, and a copper-alloy locking member engageable with said abutment surfaces and constructed and arranged to lock said block in closing position under ballistic pressure and to release said block upon diminution of pressure to a predetermined degree.

20. In a breech locking mechanism of that type having a movable breech closure and means for holding said closure in opposition to breech pressure, in combination a lock, and an abutment member having an inclined face for engagement by said lock, said lock and said member being of material of such relative physical characteristics as to cause one of them to become the contour-negative or matrix of the other when subjected to ballistic pressure.

21. In a breech locking mechanism, in combination a locking bolt, and a part cooperating therewith, said bolt and part being relatively movable under breech pressure and being constructed of materials having such relative hardness as to permit rugosities of one to be embedded in the surface of the other when such parts are subjected to ballistic pressure.

22. In a gun, mechanism for opposing the explosion reactions comprising opposing abutments, one of the abutments being formed of an alloy containing approximately nine-tenths copper.

23. In a gun, mechanism for opposing the explosion reactions comprising opposing abutments, one of the abutments being formed of an alloy containing approximately nine-tenths copper and approximately one-tenth aluminum.

Signed by me at Cleveland, Ohio, this first day of October, 1920.

THEODORE H. EICKHOFF.