July 6, 1948. A. CROSSLEY 2,444,633

OBTURATOR FOR ORDNANCE

Filed Jan. 12, 1944

3 Sheets-Sheet 1

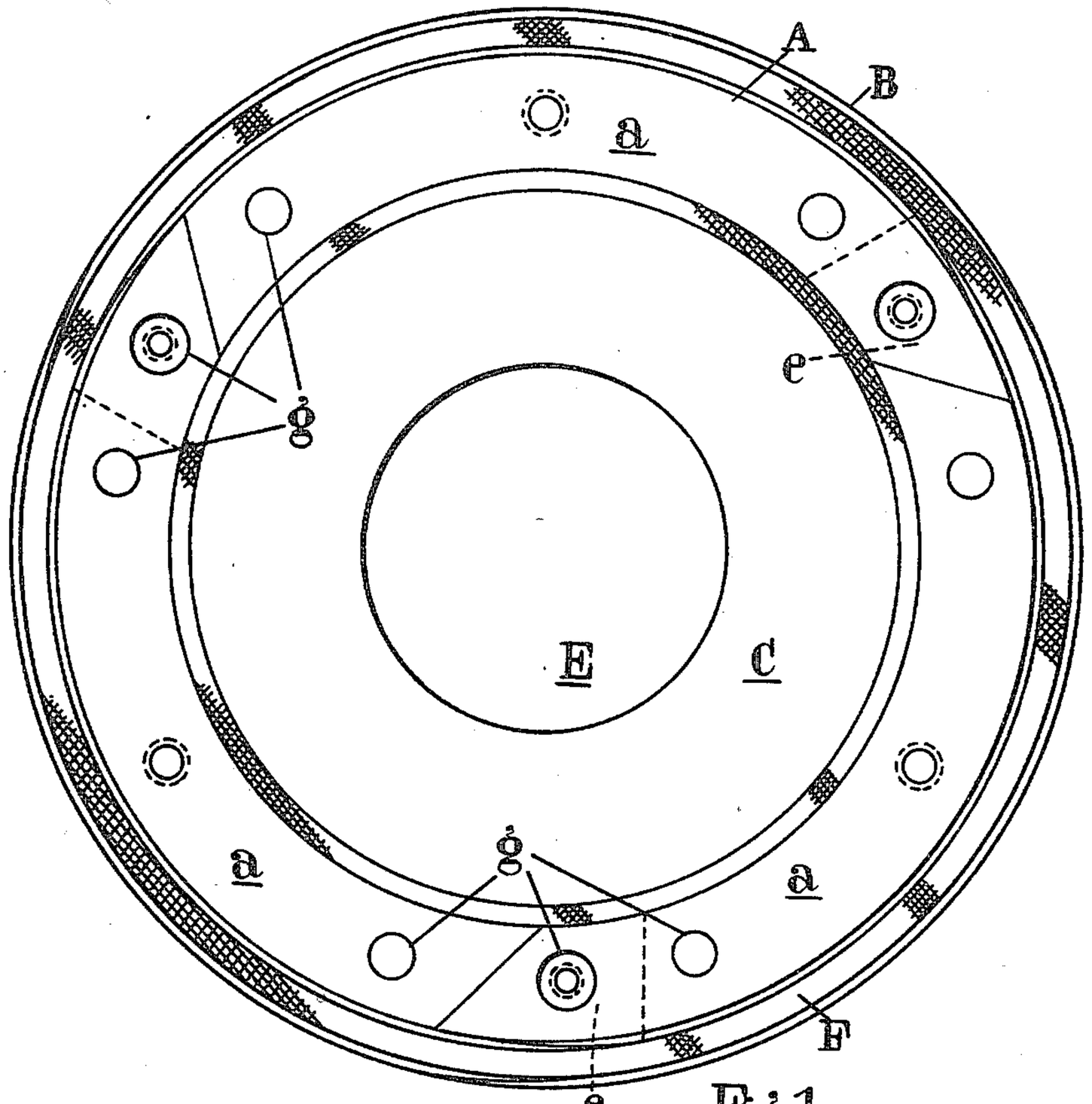

Fig.1.

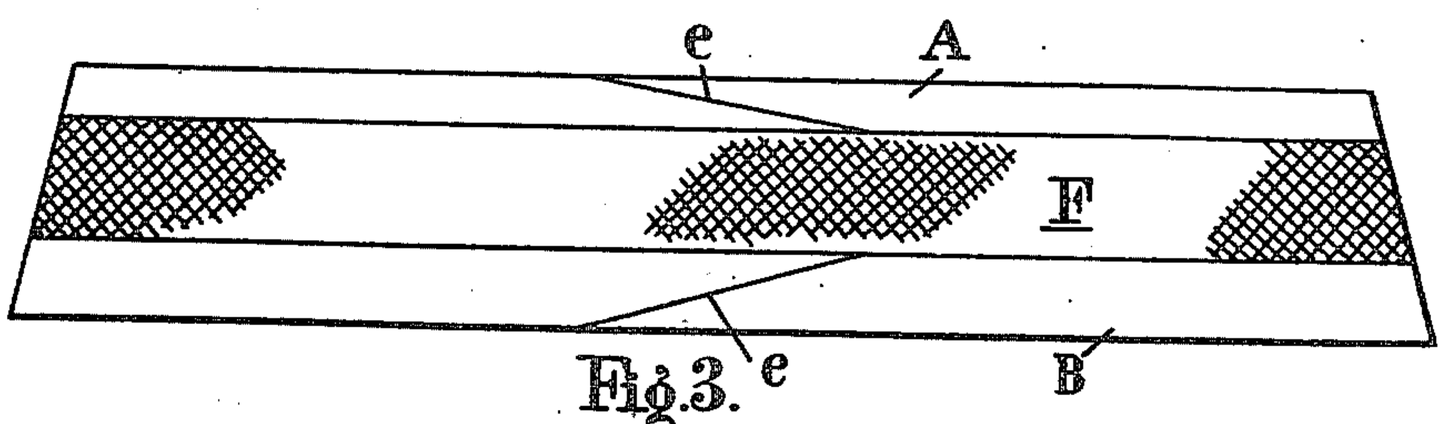

Fig.3.

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July 6, 1948. A. CROSSLEY 2,444,633

OBTURATOR FOR ORDNANCE

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3 Sheets-Sheet 2

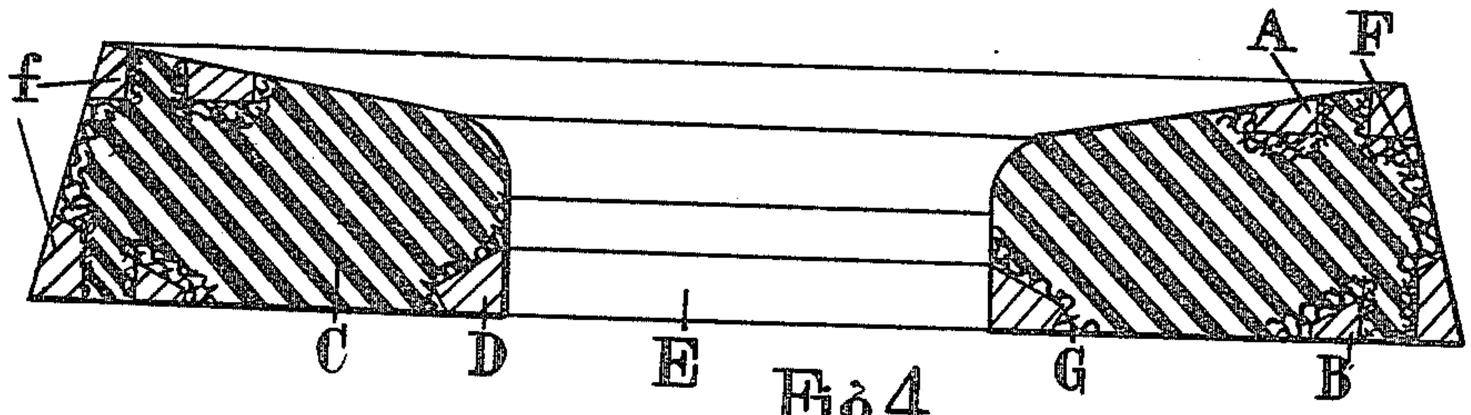
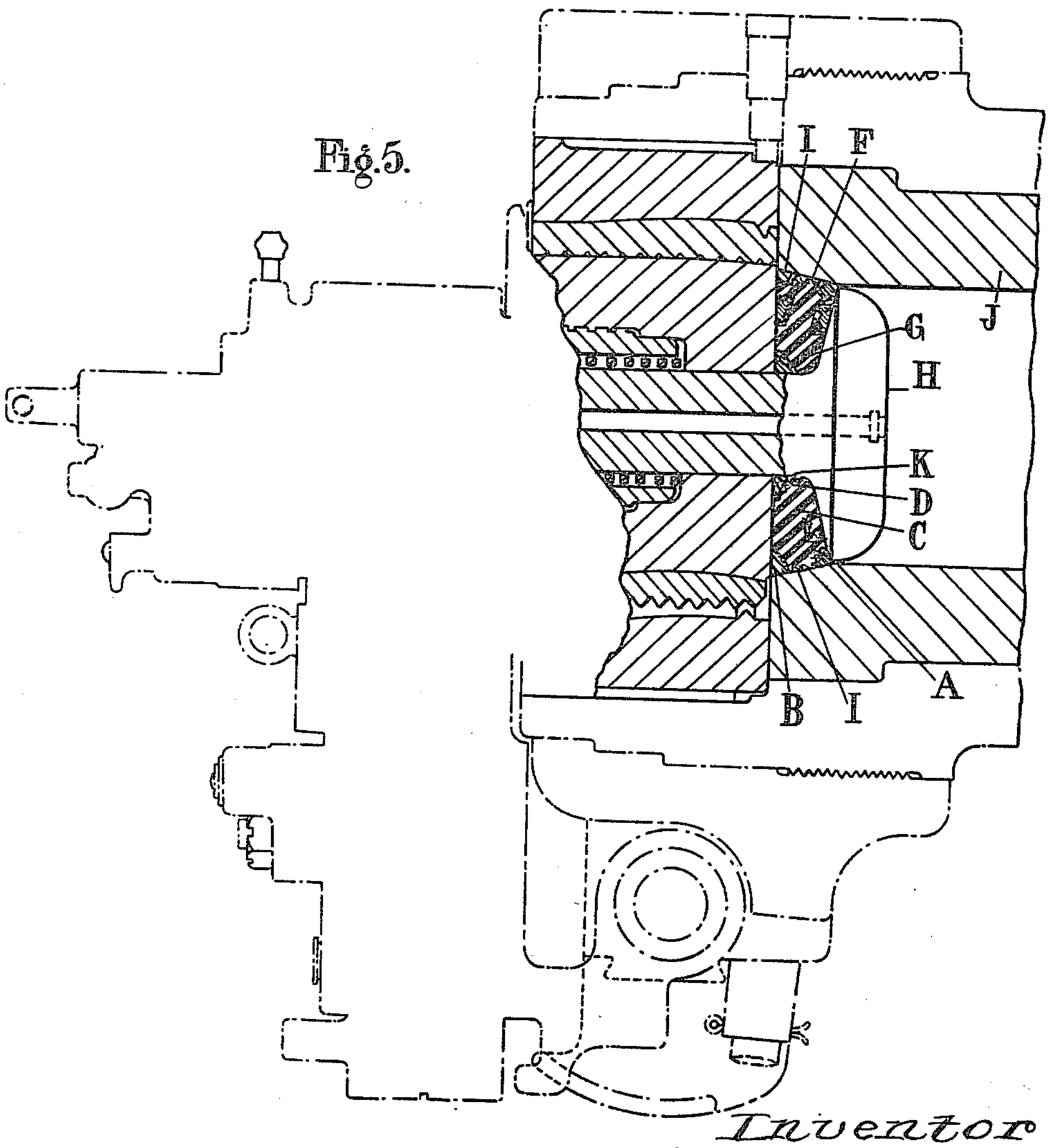


Fig.4.

Fig.5.



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July 6, 1948. A. CROSSLEY 2,444,633

OBTURATOR FOR ORDNANCE

Filed Jan. 12, 1944 3 Sheets-Sheet 3

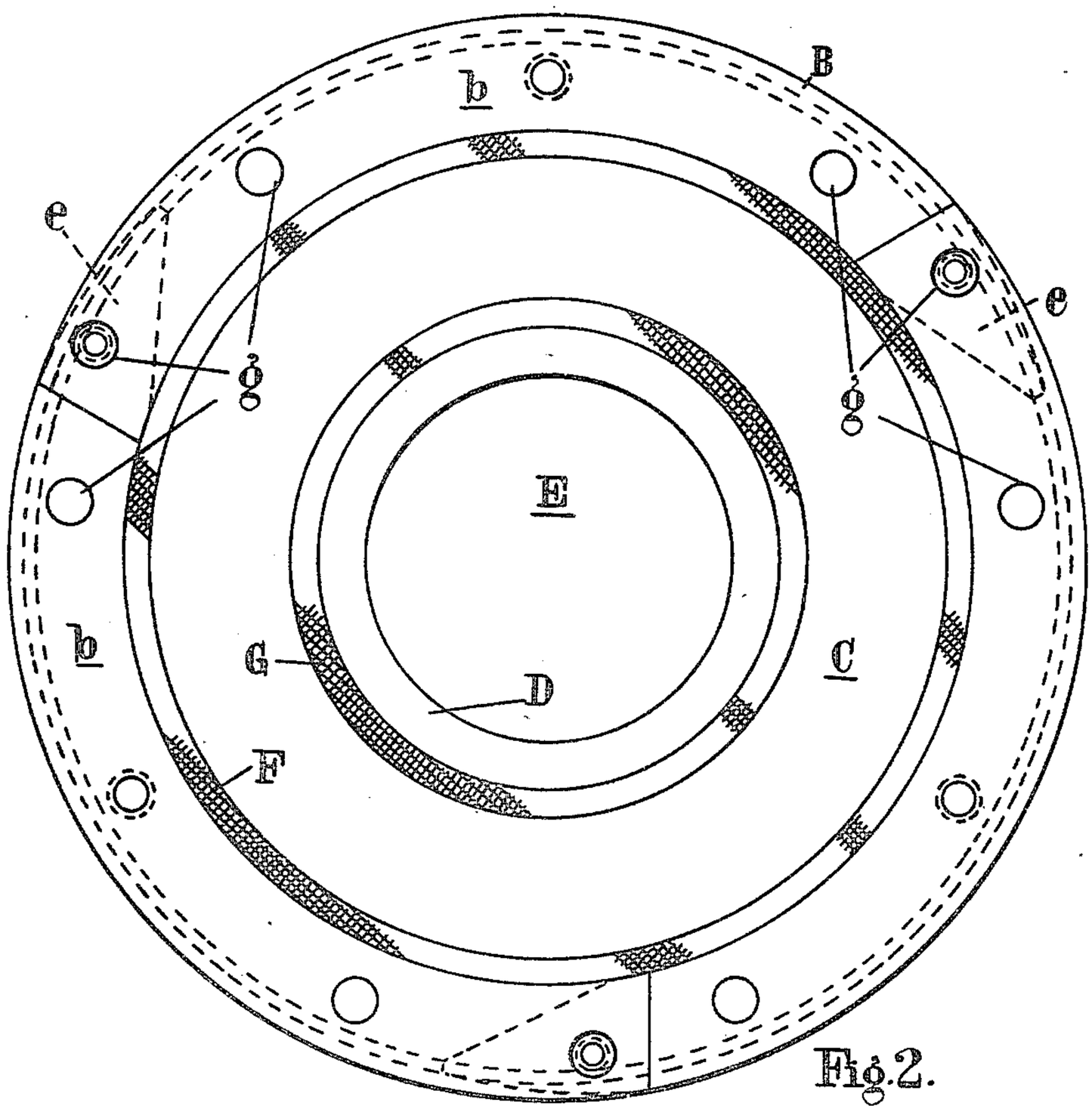

Fig.2.

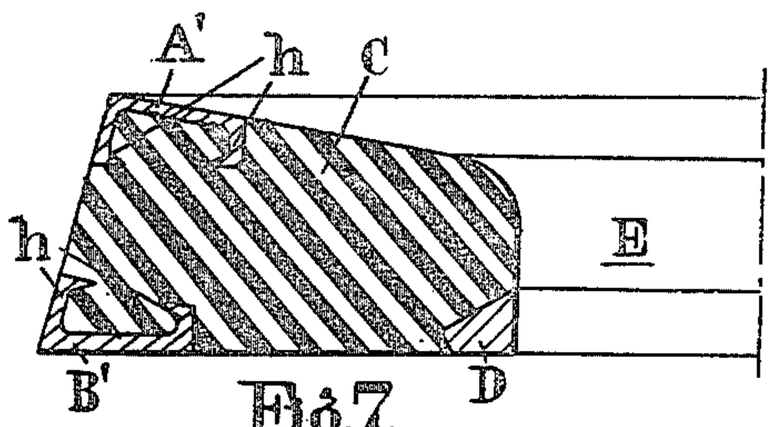

Fig.7.

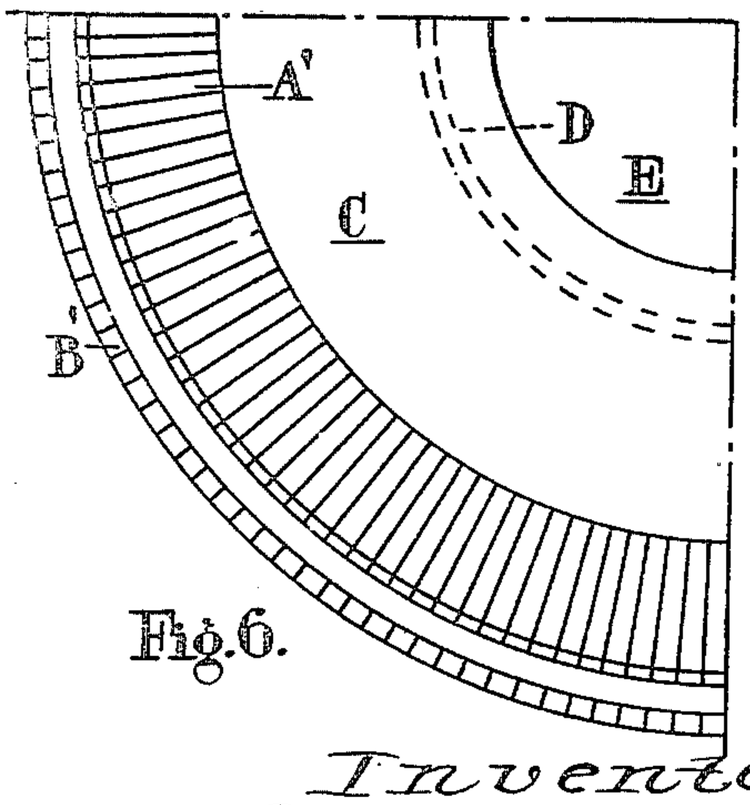

Fig.6.

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UNITED STATES PATENT OFFICE

2,444,633

OBTURATOR FOR ORDNANCE

Arthur Crossley, Bolton, England

Application January 12, 1944, Serial No. 518,029
In Great Britain June 8, 1943

12 Claims. (Cl. 89—26)

1

This invention relates to obturators and obturator pads and rings for ordnance and the like where an effective seal is required to withstand the heat and high pressure conditions developed on the firing of a propellant charge or the like.

In the past, obturators consisted of pads of a mixture of materials such as asbestos fibre and rape or similar oil affording a plasticity such that the pads owed their sealing qualities to the deformability and capacity of the material to take up the required shape under the pressure produced by the combustion of the propellant. The pad forming materials were enclosed in a cloth or jacket covered by a brass wire mesh and mounted between loose inner and outer rear and front metal rings. The obturator also contained a copper protecting disc covering the front face of the pad passing between the front outer ring and the pad and continuing for a short distance on to the sealing face.

Owing to the fact that these pads could only be manufactured to generous limits, it is not uncommon for these to require from 1 to 4 adjusting discs to mount at the rear of the obturator to give the necessary adjustment.

Obturators of this known kind suffered from many defects and objections. A pad might last satisfactory for a time but the safety period was uncertain and little reliance could be placed thereon in prolonged use and no guarantee as to performance could be given. Owing to the fragile and unstable nature of the pads it was necessary, before putting into service, for the pads to be inserted into heavy presses specifically provided for this purpose on the gun site. It was also, for the same reason, standard practice for pads to be removed from the guns, during transit and periods of inaction. It would appear that this constitutes a disadvantage in the event of a surprise attack on the part of the enemy.

It is sometimes necessary during action for an obturator to require adjustment. This is done by the addition of adjusting discs, which involves the removal of the slide box, vent axial nut and the withdrawal of the vent axial from the breech screw. In view of the fact that the obturator comprises five to nine loose pieces according to the number of discs used, this whole process of adjustment was not easy and might have to be carried out under very difficult circumstances.

In some marks of guns considerable trouble has been experienced due to the permanent distortion of the rear outer rings taking place. In these marks of guns, the portion of the copper protecting disc which continued for a short distance on to the sealing face, has been found to be subject to fatigue during protracted action, re-

2

sulting in small pieces of the disc becoming detached with obvious ill-effect.

Further, the manufacture of obturators was a relatively slow and skilled process particularly in reference to the production of the metal rings above mentioned. These rings had to be made with extreme accuracy and their manufacture was a lengthy and highly skilled operation. Consequently obturator ring manufacture did not lend itself to mass production and in fact constituted a serious delay in the production of obturators. In use the single piece rings were subject to distortion under the heavy pressures to which they were subjected and replacements were not infrequent.

The object of the present invention is to obviate the above difficulties and defects and to provide a reliable unitary obturator which can be relied upon to perform its function for an indefinitely long period wth safety and one which can be standardised and satisfactorily guaranteed by reference, for example, to stress-strain graphs indicating a known measured factor of safety.

An aim of the invention is, further, to avoid or discard the plasticity or extrusion sealing principle upon which the obturators in the past were based in favour of a restorable expansion effect, that is to say where the seal is produced by material expanding under the pressure in question and contracting or recovering in shape upon the relief of said pressure, thereby enabling (*a*) stress-strain graphs to be readily plotted and a factor of safety be predetermined, (*b*) obturator presses to be entirely dispensed with, (*c*) obturators to remain in the guns at all times to be in readiness for immediate action, and (*d*) a complete elimination of copper protecting discs.

Another aim of the invention is to provide self-accommodating rings or annularly arranged elements associated with an obturator pad and adapted to stand up to the pressures involved without distortion and capable of mass production within fine limits of accuracy by relatively unskilled or semi-skilled engineering production.

Another aim of the invention is to provide a one-piece obturator so that, in event of the vent axial assembly requiring dismantling for any reason, the minimum number of parts would have to be handled and little or no adjustment to the obturator would be required when re-assembling.

The term "obturator" is used herein to refer to the article as a whole or the finished article ready for insertion in the cone seating of the barrel between the vent axial bolt and the face or adjusting disc of the breech bush. The phrase "obturator pad" or the term "pad" is used of the body material or seal making composition shaped to pad form before receiving, or exclusive of, the

metal rings (i. e., the inner and outer rear rings or the front (outer) ring).

The invention consists in an obturator comprising a pad of a heat-resisting and resilient material or composition embodying a fibrous or inert filler material and a binder consisting mainly of rubber, synthetic rubber or material possessing sufficient elastic or resilient characteristics for the purpose in view.

The binding material may, for example, be the synthetic rubber material known by the registered trade-mark "neoprene" and "Thiocol." Where a natural rubber is utilised the quantity employed, its dispersion and the addition of modifying agents should be such that the pad is unaffected by the temperatures involved in the use of the obturator and should possess oil resisting qualities.

In addition to material (or materials) of the above character the pad forming composition comprises a vulcanizing or curing agent (or agents), a plasticizer (or plasticizers) to enable control or modification of the stress-strain qualities of the pad to be effected, and an anti-oxidant agent (or agents) for the purpose of controlling the ageing of the binder under varying temperatures or to suit various or particular climatic conditions.

The improved pad is relatively incompactable such that it is not subject to destruction or crushing by the repeated pressure blows of gun discharges but is temporarily expanded by the pressure and owing to its elasticity recovers on the subsidence of the pressure.

The invention further consists in an obturator pad as above indicated wherein the surfaces or parts of the pad exposed or subjected to stresses calculated to tend to cause extrusion of the material in joints, corners or clearances, are covered, enclosed, or strengthened or reinforced by a layer of fibrous or fabricated material (with or without the inclusion of metal) applied to the pad material, or have a stiffening or reinforcing layer or zone embodied in the pad material, for controlling or modifying the extensibility of the pad-forming material at the areas in question.

The invention also consists in the construction of obturator rings so that such are capable of circumferential expansion and retraction by aid of a segmental arrangement wherein the relative movement occasioned by the extension and retraction at the segmental junctions is distributed over a number of joints.

According to one form an obturator ring (or rings) comprises a plurality of elements of segmental shape having at their extremities inter-engageable bevelled jointing areas adapted to be assembled in annular form with the bevelled ends overlapping and capable of extension and retraction circumferentially when upon an obturator pad.

According to another form the improved obturator ring construction comprises a multitude of butt-jointed segments the butt joints being transverse (preferably at right-angles) to the outer plane of the ring and the number of the joints are such that on circumferential extension and retraction, the relative joint displacement is reduced to an insignificant minimum.

In both forms it is preferred to provide the rings with means whereby they may be keyed or otherwise physically attached to the material of the pad.

The invention also consists in an obturator comprising a pad of elastic or resilient material or composition and front and rear rings each formed of a plurality of segments capable of circumferential extension and retraction and attached to the pad so as to provide a self-contained obturator unit.

The invention further consists in a method of manufacturing obturator pads according to the invention comprising making a composition including the materials indicated, evaporating the constituent solvents, moulding the mixed materials under pressure to form a blank, repressing the blank in a die with ring segments of the character above specified in position and vulcanizing the whole under appropriate temperature and pressure conditions.

The invention will be further described below with reference to an example of a suitable mode of carrying the invention into effect.

The pad composition comprises a mixture of the materials in the undermentioned proportions:

	Per cent
Long Rhodesian asbestos fibre	64.26
Neoprene E	25.726
Wood rosin	1.284
Zinc oxide	1.284
Sulphur	.770
Nonox S	.513
Nonox CC	.513
Plasticizers, such as medium mineral lubricating oil	3.850
Dibutyl phthalate	1.800

It is understood that neoprene and Nonox are registered trade-marks and it is to be appreciated that in place of these proprietary materials, other materials having a similar composition may be employed.

The wood rosin, zinc oxide and sulphur operate as curing and vulcanizing agents for the neoprene E. The Nonox S and Nonox CC are anti-oxidants suitable for neoprene, while the mineral oil and dibutyl phthalate are plasticizers. The nature and the quantity of the plasticizers may be varied according to the temperature conditions to which the particular obturator pad concerned is to be exposed and/or according to the mark of gun in which such is to be used. Further, the plasticizers may be varied according to whether a stress-strain curve is required at a normally high or low climatic temperature, i. e., whether the pad is to be used principally in the tropics or under arctic conditions.

The accompanying drawing illustrates one form of obturator according to the invention by way of example. In the drawings—

Figure 1 is a plan view of the obturator.

Figure 2 is an underneath plan.

Figure 3 is a side elevation of the obturator and

Figure 4 is a cross-sectional view of the obturator seen in Figures 1, 2 and 3.

Figure 5 is a sectional view of the breech of a gun illustrating an obturator in position.

Figures 6 and 7 are respectively part plan and part cross-sectional view of a modified form of obturator.

Referring to the drawings, the metal outer front and rear rings A and B for the pad C are composed of a plurality of segments respectively marked *a* and *b*, three having been found a suitable number although two or more than three may be employed if desired. The segments in cross section (see Figure 4) are of triangular shape, the apex of the triangle being truncated if desired. Each segment terminates in a bev-

elled plane *e* extending from the front face of the segment to the rear, the arrangement being such that the bevelled surfaces, when the segments are assembled together in annular form, contact with one another so that in the circumferential extension or retraction of the annulus, the bevelled areas ride or slide upon one another whilst still maintaining a close extrusion preventing joint.

It will be appreciated that by increasing the number of segments the number of jointing areas is increased and hence the amount of relative movement at each joint is proportionately reduced. The angle of bevel may be 8° to 15°, or thereabouts, a bevel of about 10° having been found to be a serviceable mean.

The triangular or wedge-shaped segments are disposed with the base *f* of the wedge or triangle at the exterior periphery of the annulus.

An inner rear ring D is provided at the corner of the obturator aperture E through which the vent axial bolt passes; this ring may be a continuous solid annulus of wedge shape in cross section.

Each segment of the outer rings is formed with a plurality of holes or cavities *g* which may pass through the segments from face to face; one or more of these holes may be positioned in the area of the bevelled joints. The purpose of these holes or apertures is to enable the pad material in the manufacture of the obturator to enter them so that the segments are keyed securely to the pad material.

The holes may be countersunk and those employed in the bevelled joint area may be also employed for the purpose of temporarily connecting the segments together by screw-threaded means for machining and like manufacturing purposes. Alternatively the segments may be provided with teeth or projections or with dovetail or like grooves for the same purpose, or apertures and other formations may be combined to effect the required attachment.

In manufacturing the composition, asbestos is suitably opened and cleaned. The other ingredients listed above are made into a cream with a sufficient quantity of the appropriate solvents in a ball mill. This cream is then added to the asbestos fibre and mixed in a suitable paste mixing machine for about half an hour or other suitable period and the whole is dried to remove solvent.

Assuming that portions of the pad are to be protected with a layer of applied fabric as in the form of the invention illustrated in the drawing, this fabric, which may be suitably of asbestos cloth woven together with fine brass wires, is impregnated with the neoprene cream mixture referred to above and suitably dried. Two cloths or a double cloth may be employed, such as seen at F, covering the outer periphery of the pad where it lies between the rings A and B and also underlying said rings. A cloth which may be of single thickness may be also introduced, as at G, to lie under the ring D and overlie and protect the adjacent portion of the pad material.

It will be understood that the number and/or thickness of the cloths may be varied to accord with the size of obturator to be made or the gun pressures to which it is to be subjected. In places where the fabric underlies holes in the segments, the cloth is partly pushed up into the holes and/or the composition is extruded through the fabric into the holes.

A sufficient weight of the impregnated fibre is

put into a forming mould and pressed into a rough blank. The blank is removed and suitably cut and sewn impregnated cloths F and G then are fitted into the required positions, that is to say over the outer perimeter of the pad and at the rear inner peripheral corner thereof to afford stiffening control adjacent the ring corners. The blank is then repressed in the same die.

The final operation is the application of the outer front and rear rings A and B and the solid inner rear ring D. The segments are assembled together to compose the outer rear ring and the outer front ring and all rings are then positioned in a finishing die with the blank, and the whole is vulcanized for about an hour at 300° F. at pressures varying from one to three tons per sq. inch calculated on the projected area of the obturator according to the mark of gun for which it is intended and the stress-strain graph required. Assuming that these operations have been performed correctly no further grinding or adjustment is necessary and the obturator is ready for test and subsequent service.

Obturators are tested in a press fitted with gauges to indicate pressure, and dial reading micrometers are applied to the inner and outer surfaces. Pressure is applied and the readings taken of the pressure at various stages with the micrometer deflections showing the amount of bulge or expansion taking place at the pad peripheries. From these figures a stress-strain graph for the particular obturator under test may be plotted from which its safety factor may be noted.

Protracted experiments have proved that if the pad composition or mixture when tested and its behaviour plotted on a stress-strain graph is too hard, there is danger of gas wash, and if only slightly too hard the factor of safety for both the gun and the crew is reduced. A hard pad, however, has the longest life assuming that the limit of hardness is not reached. On the other hand a pad which is too soft whilst perfectly safe so far as damage to the gun or crew is concerned, tends to extrude over the front and rear outer steel rings and at the rear inner point of contact with the vent axial bolt. This gives the pad a relatively short life as necessarily the extrusion is progressive with successive rounds fired by the gun. It is therefore obvious that the ideal pad is a balance between the two factors, namely a factor of safety and one promoting long life.

These difficulties are avoided by making the composition of the pad of a mean soft-hard consistency or a softish pad may be made satisfactory by the application of asbestos wire mesh cloth as described above or by making the composition of non-uniform characteristics, that is to say by introducing a harder or more resistant layer or zone in the areas which might tend to extrude. For example, the bulk of the pad can be made soft in order to keep a good safety factor while at the critical extrusion points or areas a similar mixture is employed but modified to an extent to give a high modulus at the extrusion points. This effect can also be produced either by applying controlling material to the pad or by moulding a supporting material or modified mixture integrally with the pad. Alternatively the pad mixture may comprise in the vicinity of the areas in question incorporated reinforcing cloth metal mesh or the like or a zone of harder neoprene asbestos mix.

In use, an obturator made as above described is fitted into the gun (see Figure 5) with the front

face of the obturator seated directly onto the rear of the vent axial bolt head H without the use of the usual copper protecting disc and with the outer periphery of the pad in a position for abutment against the cone seating I of the barrel J.

Due to the accurate limits to which the obturator according to the invention can be manufactured all adjusting discs are entirely dispensed with unless the cone seating or screw of the gun is worn. Further, owing to the elastic nature of the pad, the pressure of the vent axial spring (not shown) produces a slight deflection on the periphery of the obturator when the gun is open, and the returning of the pad to normal by the closing of the gun is indicative of the desired degree of obturation. The amount of deflection is controllable by varying the pad composition in the manufacture of the obturator.

When the gun is fired the pressure of discharge transmitted through the vent axial bolt compresses the obturator pad, causing it to extend or bulge outward and inward so that a seal is made between the outer periphery of the pad and the cone seating I, and also at the neck or junction K of the axial bolt with its head. Owing to the resiliency of the pad, as soon as the pressure of discharge is relieved the pad recovers and contracts to normal configuration. As the material of the pad is such that, in its confined seating chamber, it is not stressed beyond its elastic limit and does not extrude, the pad may be used for very long periods and for firing a great number of rounds without requiring renewal or any attention, and may well last the life of the barrel of the gun.

According to another form of obturator ring construction illustrated in Figures 6 and 7, the outer front and rear rings are composed of a multitude of segents A', B', for example a ring may comprise a number of segments in the neighbourhood of 200. The segments instead of having long bevel joints as in the form previously described have flat side faces butt-jointed together, or are otherwise provided with joint forming surfaces. The butt-joining surfaces are preferably in radial planes at right-angles to the outer surface of the rings. The under portion of each segment may be provided with undercut or dovetail grooves or hook members *h* for engagement with the pad material so that the segments are firmly embedded in or attached to the material constituting the pad. A solid inner rear ring D is provided and cloths or fabric or other reinforcement (not shown in Figure 7) are arranged in the manner above described.

It will be appreciated that where a multitude of joints are provided the relative displacement at any one joint owing to expansion and contraction is reduced to so small a minimum that the clearance is so fine that any significant effect is incapable of being produced by the pressure gases.

I claim:

1. An obturator for sealing the breech of breech loading guns comprising a non-metallic annular pad of a resilient composition, and front and rear protecting rings for the pad keyed to said composition and, with the pad, forming a unitary structure, the resiliency of the pad being such that under axial pressure of discharge of the gun in which the pad is used, said pad is expanded transversely to make lateral sealing contacts while on subsidence of the pressure the pad recovers and returns substantially to normal.

2. An obturator for breech loading guns as claimed in claim 1, wherein at least one of the rings is formed of a plurality of segments to render that ring capable of circumferential expansion and contraction.

3. An obturator for breech loading guns as claimed in claim 1, wherein at least one of the rings is formed of a plurality of segments having overlapping beveled joints to distribute the movement of the segments under discharge pressure of the gun equally around the obturator and afford the minimum clearance through which the composition can extrude.

4. An obturator for breech loading guns as claimed in claim 1, wherein at least one of the rings is formed of a multitude of butt-jointed segments whereby under pressure of discharge the maximum clearance of any joint is so small as to prevent extrusion of the composition.

5. An obturator for breech loading guns as claimed in claim 1, wherein at least one of the rings is formed of a plurality of segments each provided with apertures into which portions of the pad extend for keying that ring to the pad.

6. An obturator for inclusion between the vent axial bolt head and the breech screw face of a breech loading gun of a calibre not less than 4 inches for sealing the breech thereof, comprising: an annular pad of resilient synthetic rubber composition, capable of resisting oil and withstanding the high temperatures generated upon discharge of the gun and a sufficient amount of an inert filler material to impart to the composition load resistance and control of stress-strain qualities, the resilience of the pad being such that under axial pressure of the discharge of the gun said pad is expanded transversely to make lateral sealing contact with the cone seating of the gun, while on subsidence of the pressure the pad recovers and returns substantially to normal condition, and front and rear protecting rings for the pad capable of expansion and contraction upon the firing of the gun and interlocked with the pad for retention in their locations on those portions of the pad adjacent its periphery.

7. An obturator for breech loading guns as claimed in claim 6 characterised in that the protecting rings are attached to the pad by a keyed connection therewith.

8. An obturator for breech loading guns as claimed in claim 6 wherein at least one of the rings is formed of a plurality of segments having overlapping bevelled joints such that the ring is capable of circumferential expansion and contraction to distribute the movement of the segments under discharge pressure of the gun substantially equally around the obturator and to afford the minimum clearance through which the material of the pad can extrude.

9. An obturator for breech loading guns as claimed in claim 6 characterised in that the protecting rings are attached to the pad by a keyed connection therewith and at least one of the rings is formed of a multitude of butt-jointed segments whereby under discharge pressure of the gun the clearance between any joint is so small as to prevent extrusion of the pad material therethrough.

10. An obturator for breech loading guns as claimed in claim 6 wherein at least one of the protecting rings is formed of a plurality of segments, each provided with apertures into which portions of the pad material extend to provide the attaching means of the ring to the pad.

11. An obturator for breech loading guns as

claimed in claim 6 wherein the surfaces of the pad which contact with and are adjacent the protecting rings are reinforced by a bonding layer of fabricated material secured to the pad.

12. An obturator for breech loading guns as claimed in claim 6 wherein the surfaces of the pad which contact with and are adjacent the protecting rings are reinforced by a fibrous material forming a stiffening layer embedded in and bonded to the pad for modifying the expansibility of said pad at said surfaces.

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