

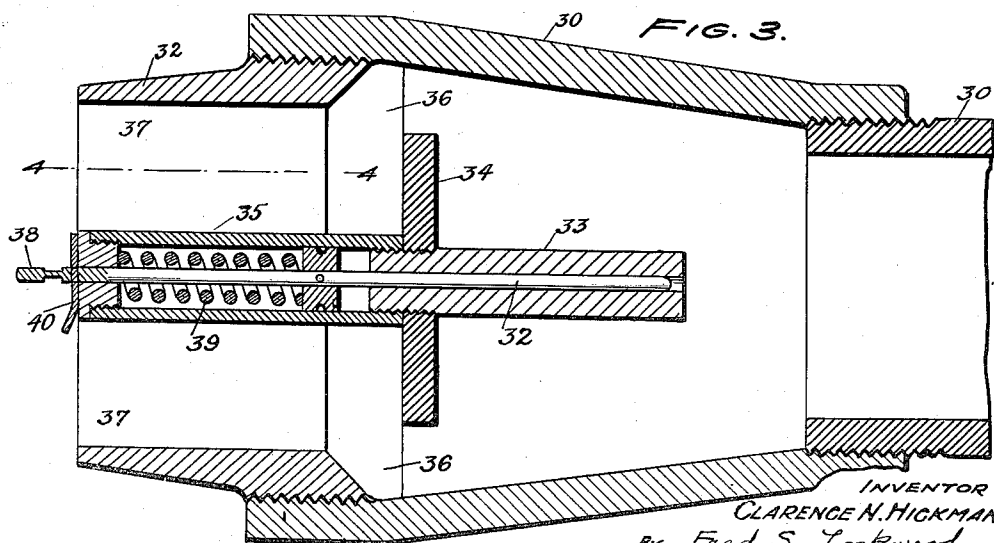
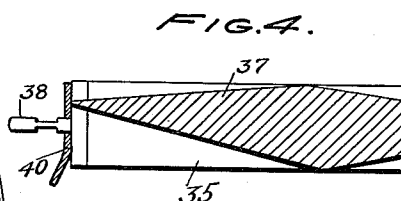
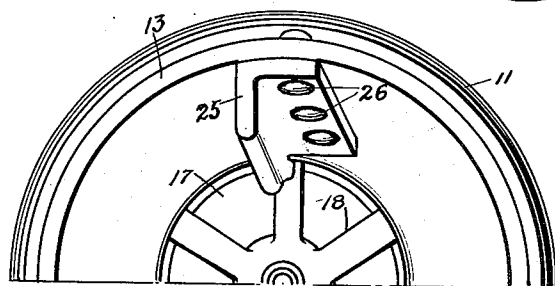
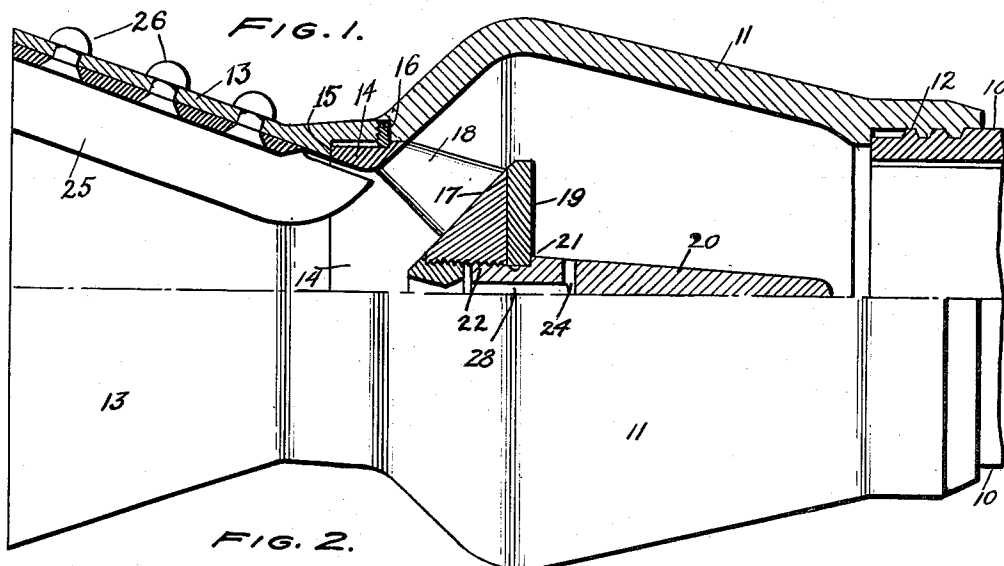
May 27, 1952

C. N. HICKMAN
RECOILLESS GUN

2,598,256

Filed April 21, 1945

2 SHEETS—SHEET 1



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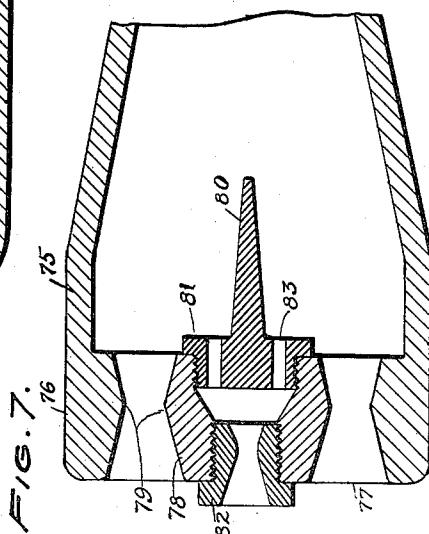
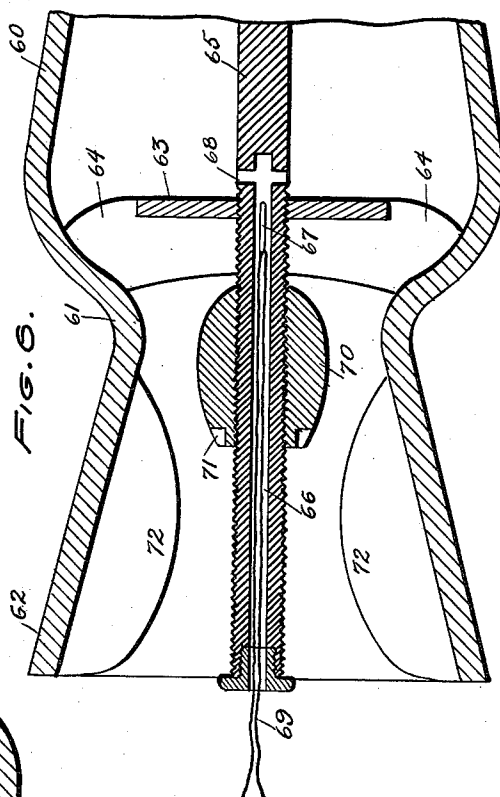
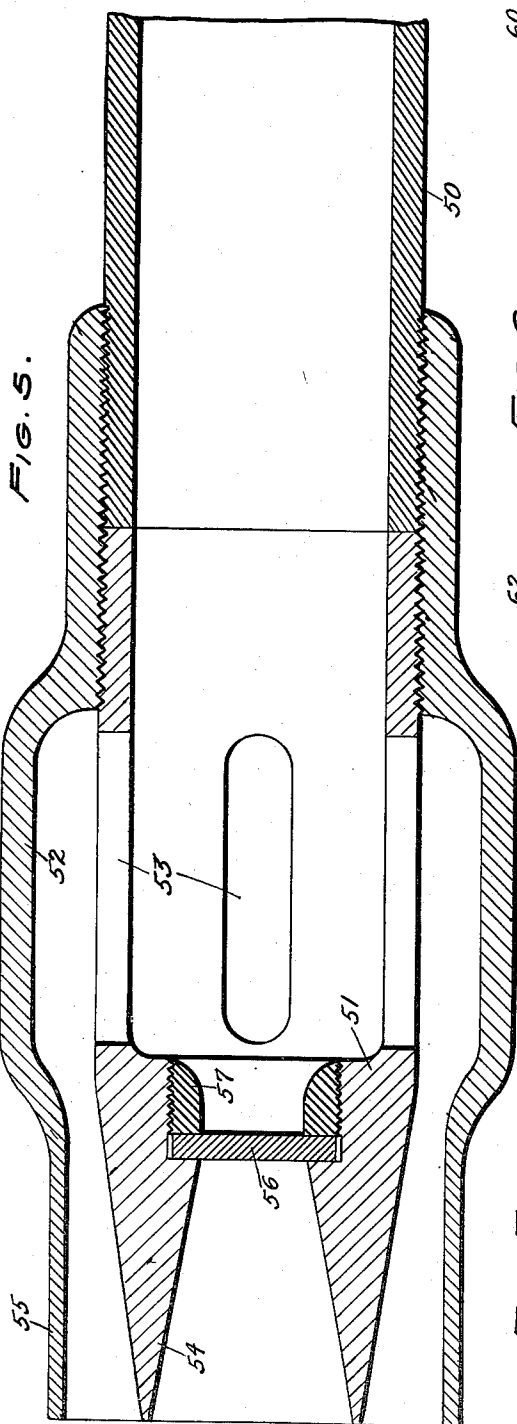
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2 SHEETS—SHEET 2



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2,598,256

RECOILLESS GUN

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Application April 21, 1945, Serial No. 589,500

2 Claims. (Cl. 89-1.7)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates, generally, to a recoilless gun, and more particularly to a recoilless attachment adapted to convert the conventional 4.2 inch chemical mortar into a lightweight, readily portable, weapon.

Ordnance such as the conventional 4.2 inch chemical warfare service mortar (described on pages 371-379, Chemicals in War, Prentiss, McGraw-Hill Book Co., 1937) is necessarily heavy because of the recoil forces which must be absorbed. Such guns usually require a sturdy mount and/or a heavy base plate which are not easily moved and set up under battle conditions. The conventional base plate for the 4.2 inch chemical mortar weighs about 185 pounds.

As a result of my research and experiments in the development of rockets and propellants for rockets, I have determined that ordnance such as the chemical mortar may be converted into a relatively light weight weapon by replacing the conventional mortar tube cap with a reaction chamber having an open nozzle or venturi. The use of such a chamber provides a recoilless gun which may be supported on a light weight mount and which requires no base plate. Such a recoilless gun may be easily broken down for transportation into three components each weighing less than 50 pounds.

It is therefore one of the objects of this invention to provide a light weight gun of the recoilless type which is readily portable.

It is another object of this invention to provide a muzzle loaded recoilless gun.

It is a further object of this invention to provide a recoilless attachment adapted to be utilized with the conventional barrel or tube of the 4.2 inch chemical warfare service mortar.

It is a further object of this invention to provide a recoilless attachment for the chemical mortar which sets up forces counteracting the tendency of the mortar to rotate during firing.

Still another important object of the invention is the provision of a recoilless attachment for muzzle loading mortars with means for adjusting the attachment to compensate for manufacturing tolerances and erosion.

Other objects and advantages of the invention will be readily apparent from the following description of the accompanying drawings in which:

Fig. 1 is an elevational view partly in section of a preferred construction of a recoilless combustion chamber secured to the end of a mortar tube;

Fig. 2 is an end elevation view of a portion of the combustion chamber shown in Fig. 1, showing one of the plurality of vanes provided in the combustion chamber nozzle;

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Fig. 3 is a vertical sectional view of a modified construction of a combustion chamber secured to the end of a mortar tube and provided with a manually operated firing pin;

Fig. 4 is an elevation view partly in section showing the tapered cross section of the nozzle vanes of the Fig. 3 construction;

Fig. 5 is a vertical sectional view of another construction of combustion chamber secured to the end of a mortar tube;

Fig. 6 is a vertical sectional view of a recoilless combustion chamber having an adjustable throat; and

Fig. 7 is a vertical sectional view of a modified recoilless combustion chamber having an adjustable throat.

Referring to the drawings for the purposes of illustration, in the embodiment of my invention shown in Fig. 1, the rear end of a conventional 4.2 inch chemical warfare service mortar tube is indicated by the numeral 10. A recoilless combustion chamber 11 is secured to the mortar tube 10 by a threaded connection 12 in place of the usual mortar tube cap. The combustion chamber 11 is provided with an open outwardly flaring nozzle 13 aligned with the bore of the tube 10. A ring-shaped throat member 14 is secured at the inner end of the nozzle 13 seated against a shoulder 15 and is locked in place by one or more set screws 16. A conical member 17 is supported centrally within the combustion chamber 11 by means of a plurality of radial arms 18 of tapered cross-section. The throat member 14, arms 18, and member 17 may be formed in one piece. A powder trap plate 19 is secured against the face of member 17 by a trap pin 20, the latter being provided with a shoulder 21 engaging the plate 19 and a threaded stud 22 extending into the central portion of member 17. The trap pin 20 is axially aligned with the mortar tube 10 and may be tapered to facilitate the centering of the propellant charge (not shown) in the combustion chamber 11. The forward end of pin 20 is shaped to engage and fire a percussion igniter carried by the propellant and projectile assembly as it is loaded into the combustion chamber through the tube 10. The pin 20 may be provided with an opening 24 therethrough to receive a rod to assist in securing the pin 20 to the member 17. The threaded central portion of member 17 is fitted with a replaceable plug 27 having a Venturi opening therein communicating through passages 28 and 24 in the trap pin 20 with the interior of the combustion chamber 11. A series of plugs 27 having openings of various sizes may be provided in order that the proper size plug may be placed in member 17 to establish recoil balance by compensating for variations in manufacturing tolerances and/or variation caused by erosion.

A plurality of vanes 25 are provided on the

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inner face of the nozzle 13. The vanes 25 may be approximately L-shaped in cross section, and may be rigidly secured to the nozzle 13 by rivets 26. Although only one vane 25 is shown in Figs. 1 and 2, it should be understood that the use of six is intended, so that there will be one vane aligned with each of the six arms 18. The vanes, as shown in Fig. 2, are positioned at an angle of the order of fifteen degrees with respect to the axis of the tube 10 and chamber 11 in order to produce a rotation force sufficient to counteract the tendency of the tube 10 and chamber 11 to rotate as a projectile is fired from the rifled bore of tube 10.

A suitable mount for the recoilless gun shown in Figs. 1 and 2 may be provided of any known construction. A mount considerably lighter in weight than the conventional mount and base plate ordinarily used with the 4.2" chemical mortar may be used because the recoilless attachment described eliminates or balances the recoil and rotation forces set up when firing a recoilless gun of the character herein described. A light weight mount similar to the standard 30-caliber machine gun mount is suitable.

The mode of operation of the embodiment illustrated in Figs. 1 and 2 will now be described. The tube 10 may be aimed for high angle fire the same as a conventional 4.2" chemical mortar. A regular mortar projectile carrying a charge of propellant powder is inserted within the combustion chamber 11 about the pin 20. As the propellant powder approaches the trap plate 19, the forward end of pin 20 engages igniting means carried by the propellant and projectile, and actuates the same by percussion. The propellant charge burns within the chamber 11 and the gases produced flow from the chamber 11 between the arms 18 and outward through the nozzle 13. At the same time, the projectile is propelled forward through the tube 10, and the rifling in tube 10 gives the shell sufficient rotation to stabilize its flight. The rotational recoil caused by the rifling in the tube 10 is counteracted and balanced by the flow of gases against the angular vanes 25 in the nozzle 13. The angle of the vanes 25 with respect to the axis of the tube 10 and combustion chamber 11 is selected so that the mass and velocity of gases flowing against the vanes produce the required rotational force to counteract the tendency of the tube 10 and chamber 11 to rotate. The momentum imparted to the projectile fired through tube 10 is balanced by the momentum of the gases escaping through the nozzle 13 thereby providing recoilless gun operation. Recoil balance may be established by using a plug 27 having the proper size opening to compensate for inaccuracies in the size of throat member 14 due to manufacturing tolerances or due to erosion caused through use of the gun.

The propellant charge for the recoilless attachment for the 4.2 inch chemical mortar may comprise a laminated assembly including about 270 disks of M-6 powder, 0.026 inch thick, 3.63 inches in diameter, and 1.125 inches inside diameter, the complete propellant charge weighing about 3.5 pounds, for mortar shells weighing about 25.0 pounds. Such a charge gives a shell velocity of the order of 720 feet per second. The conventional mortar percussion means together with an added secondary igniter may be used to ignite the propellant charge.

The modified construction illustrated in Figs. 3 and 4 includes a mortar tube 30, a combustion

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chamber 31 and a nozzle 32. A central trap rod 33 provided with a trap plate 34 is supported by a central member 35, the latter being carried by a plurality of radial arms 36 and vanes 37. The vanes 37 may be tapered toward the rear of the nozzle 32 as shown in Fig. 4, one side of each vane being at an angle of about 3 degrees with respect to the tube and chamber axis and the other side of each vane being at an angle of about 13 degrees with respect to said axis. This construction provides an effective vane angle of about 5 degrees which is adequate to produce enough rotational force to counteract the tendency of the tube 30 to rotate during firing. The outer ends of arms 36 and the outer edges of vanes 37 may be welded to the inner surface of the nozzle 32, and the latter may be connected to the combustion chamber 31 by a threaded connection. The central hub member 35 and trap rod 33 carry a firing pin 38 and a spring 39 for urging the pin forward for percussion firing. A sliding bar 40 extending through the external portion of the firing pin 38 may be used to retain the pin 38 in the retracted position shown. When the bar 40 is pulled clear, the firing pin 38 is snapped forward by the compression of spring 39 until the forward end of pin 38 strikes and fires suitable ignition means carried by the projectile and/or propellant charge.

The mode of operation of the recoilless mortar of the Fig. 3 and Fig. 4 construction is similar to that of the Figs. 1 and 2 construction except that the spring operated firing pin 38 may be released to fire a propellant charge and shell loaded through the muzzle into the chamber 31 at any angle of elevation.

The modified construction illustrated in Fig. 5 includes the rear portion of a mortar tube 50, a cylindrical powder trap 51, and an outer casing 52 connecting the trap 51 to the mortar tube 50. The powder trap 51 is provided with a plurality of axially elongated slots 53 permitting the passage of gases resulting from the burning of a propellant within trap 51 to the annular nozzle or venturi defined by the rear portion 54 of trap 51 and the rear portion 55 of the outer casing 52. The trap 51 may be provided with a shear disc 56 secured in place by a threaded ring 57. The shear disc 56 serves as a safety device which will shear or blow out to the combustion chamber in the event that excessive pressures are produced by the burning of the propellant charge within the trap 51. Suitable ignition means (not shown) of the percussion, electrical or electro-magnetic induction type may be provided for igniting a propellant charge after the charge is loaded into the trap 51 through the tube 50.

The construction illustrated in Fig. 6 includes a combustion chamber 60 which may be secured to the rear portion of a mortar tube (not shown) in a manner similar to that shown in Fig. 1. The chamber 60 has a throat or venturi 61 and an outwardly flaring nozzle 62 aligned with the mortar tube. A trap plate 63 is supported in the combustion chamber 60 by a plurality of radial arms 64 secured to the walls of the combustion chamber. A trap rod 65 is supported by the plate 63 and the arms 64 in an axial position through the nozzle 62, and the venturi 61, and extends into the chamber 60. The rod 65 may have a central bore 66 to contain an electrically operated igniter or squib means 67. The bore 66 is provided with radial openings 68 within the combustion chamber, and conductors 69 are provided for connection to a firing circuit. An adjustable

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constrictor ball 70 is supported on the rod 65 and is provided with slots 71 to receive a suitable wrench for adjusting the position of the ball 70 with respect to the throat 61. Vanes 72 may be provided in the nozzle 62 somewhat similar to the construction shown in Fig. 1.

The operation of the modified construction shown in Fig. 6 is similar to that described for the Fig. 1 construction with the additional feature that the effective throat area of the venturi 61 may be adjusted by moving the ball 70 along the rod 65 until the desired throat area is obtained. The ignition of a propellant charge in the chamber 60 may be accomplished by the electrical igniter means 67 or by percussion means actuated by the forward end of the trap rod 65, as explained heretofore.

Referring to Fig. 7, a modified form of adjustable throat, recoilless combustion chamber is shown, comprising a combustion chamber 75 which is to be secured to the rear portion of a mortar tube (not shown) by threaded interconnection, as shown in Fig. 1. The interior of the rear portion 76 of the chamber 75 is Venturi-shaped and is provided with a plurality (usually six) of vanes 77, which also serve as supporting spokes for a hub 78. The exterior of the hub 78 is shaped so as to complement the shape of the end section 76 and thus form a Venturi throat 79 at the outlet of the chamber 75.

An integral firing pin 80 and powder trap 81 is supported in the front of the hub 78 as shown, while a hollowed-out plug 82 is supported in the rear of the hub 78. The hollowed-out portion of the plug 82 is Venturi-shaped, as shown, and permits the outlet of gases escaping through the port holes 83 in the powder trap 81.

Due to manufacturing tolerances, it is not practical to obtain perfect balance of recoil without the use of some adjusting means for varying the effective area of the nozzle opening. By providing a series of plugs, such as plug 27 in Figure 1 or plug 82 in Figure 7, having Venturi openings of various sizes and insertable in the central member of the nozzle in communication with the combustion chamber, a plug of the proper size may be quickly inserted to establish recoil balance. Consequently after repeated firings result in erosion which upsets the recoil balance, the balance may be re-established by substituting a plug having a smaller opening therein.

Where the recoilless combustion chambers described above are to be used for high angle firing of projectiles loaded through the muzzle of the gun tube or barrel, percussion type igniters may be used. In such cases, the propellant charge and projectile move down the gun tube or barrel by gravity until the propellant charge is within the combustion chamber and a fixed firing pin in the chamber engages and fires an igniter by percussion. In low angle fire at point blank ranges gravity may be insufficient to move a projectile and the propellant charge from the gun muzzle into firing engagement with a fixed firing pin. In these cases the projectile and propellant charge may be pushed into the firing position by a ram and then be fired by the spring firing pin of the Fig. 3 construction, or the propellant charge may be fired electrically by a squib connected to an external electrical circuit by conductors extending outward through the nozzle or venturi of the combustion chamber (as shown in Fig. 6), or it may be fired electrically by voltages induced in an enclosed ignition circuit by elec-

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tromagnetic induction. (It is also feasible to provide percussion type ignition by the use of driver means to propel the projectile and propellant charge from the gun muzzle to the firing position at all angles of fire. A driver rocket for use in this connection is disclosed in my copending application, Serial No. 594,241, filed May 17, 1945, now Patent 2,519,905.)

It will be apparent that the recoilless gun constructions shown and described herein provides a relatively light weight gun having a few readily portable parts. The recoilless gun may be easily set up for use on a light mount, or on a movable mount such as a light vehicle or an airplane. The recoil forces are balanced, including both axial and rotary recoil forces. The application of the principles of my invention to a muzzle loaded gun, such as the 4.2 inch chemical warfare service mortar does not limit the rapid fire characteristics of such weapons.

Numerous variations and modifications of my invention will be apparent from the several constructions described herein, and the invention is to be limited only by the scope and spirit set forth in the following claims.

I claim:

1. In a recoilless gun having a casing provided with a pressure developing chamber and a coaxial exhaust passage leading therefrom to the rear exterior thereof, a spider-like member removably fixed within said chamber, said member having a hub portion coaxial with said chamber and a plurality of integral vanes angularly disposed relative to the axis of and extending from said hub portion toward the walls of said chamber whereby to deflect and give a circular motion to gases exhausted axially through said exhaust passage said hub portion having a central internally threaded bore extending therethrough, a centrally recessed replaceable trap plate removably mounted on the front surface of said portion, and an elongated externally threaded replaceable trap pin threadedly secured in said bore in alignment with the bore of said gun.

2. The gun of claim 1 in which the trap pin is provided with a gas conduit leading from the front of said trap plate to the rear end of said pin and in which there is also provided a recessed plug threadedly secured in the bore of said portion to the rear of said trap pin, and adapted to restrict the backward flow of gaseous products of explosions through said hub portion.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,280,579	Stone et al. -----	Oct. 1, 1918
1,380,358	Cooke -----	June 7, 1921
1,661,091	Riabouchinski -----	Feb. 28, 1928
2,344,957	Anzalone -----	Mar. 28, 1944
2,405,414	Eksergian -----	Aug. 6, 1946
2,421,522	Pope -----	June 3, 1947

FOREIGN PATENTS

Number	Country	Date
570,257	France -----	Jan. 15, 1924
468,583	Great Britain -----	July 8, 1937
373,378	Italy -----	July 25, 1939