Feb. 26, 1946. V. F. LUCHT 2,395,488

RECOIL MECHANISM

Filed April 17, 1943 2 Sheets-Sheet 1

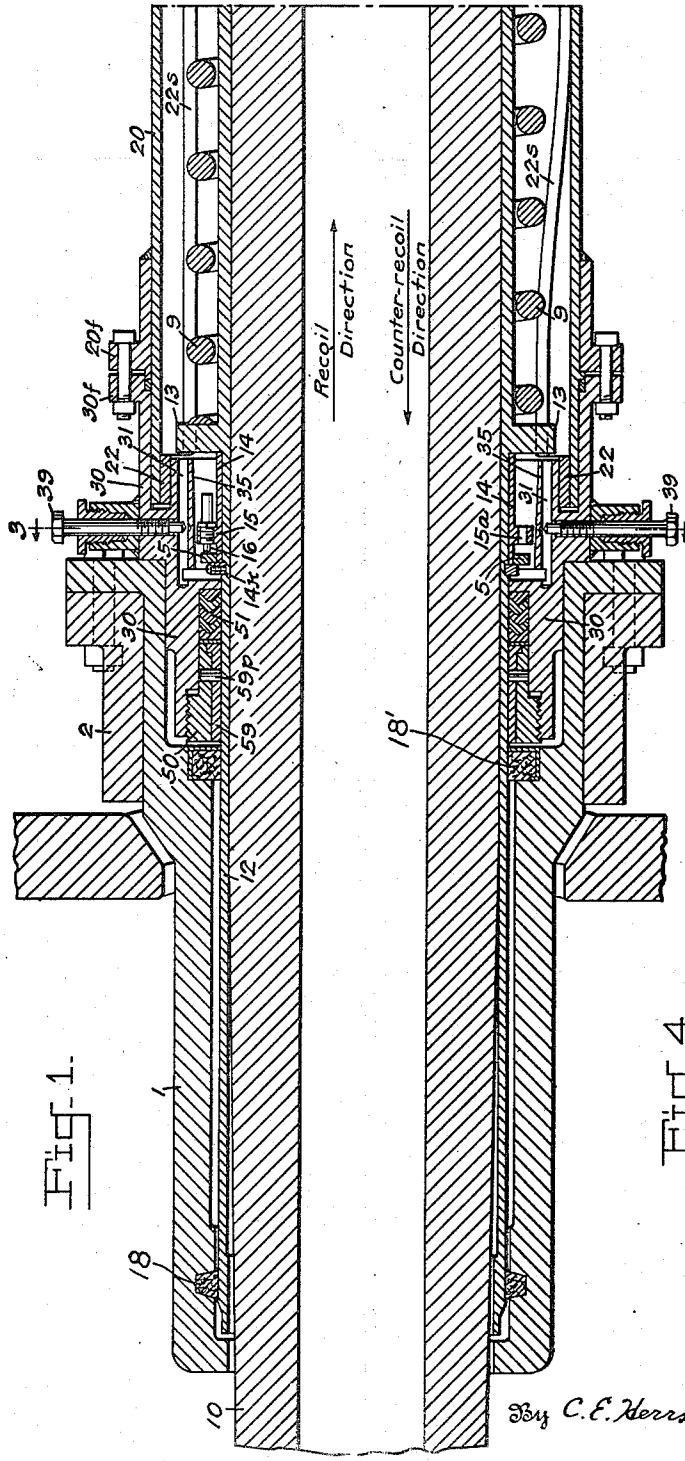



Fig. 1.

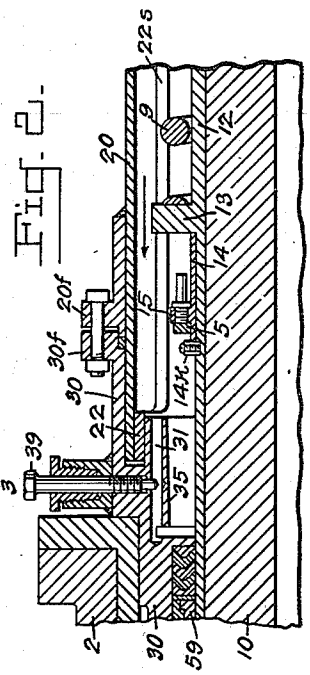


Fig. 2.

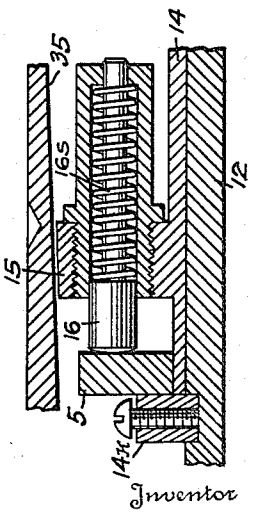


Fig. 4.

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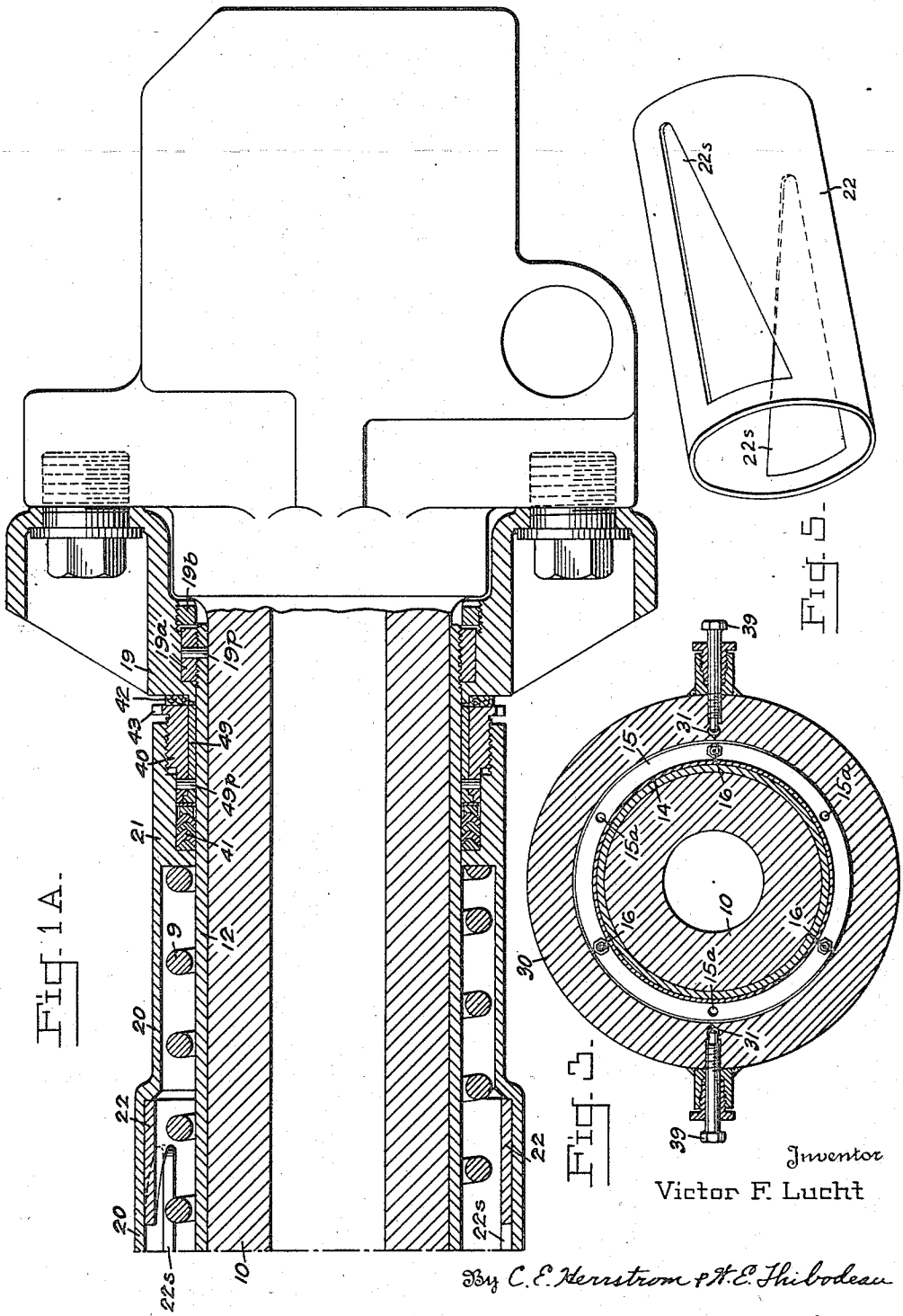



Fig. 1A.




Fig. 5.




Fig. 3.

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# UNITED STATES PATENT OFFICE

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## RECOIL MECHANISM

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8 Claims. (Cl. 89—43)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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 to recoil mechanisms for guns and is particularly adapted to guns mounted in armoured vehicles, turrets and the like, although it will be apparent that the improved recoil mechanism is not limited to such guns. Heretofore it has been the practice to provide a separate recoil cylinder (frequently also containing the counter-recoil spring) and often a separate counter-recoil buffer cylinder, both connected to the breech lug extended to one side of the breech of the gun. The presence of a separate recoil cylinder or separate cylinders for the recoil mechanism (hydro) and for the counter-recoil buffer (usually dashpot) has taken up considerable room in the already cramped quarters of the tank or turret or similar gun chamber which could well be utilized for other purposes. One of the objects of this invention is to devise a recoil mechanism for the type of gun described which would eliminate the loss of space due to the need of separate cylinders for the recoil mechanism.

In the use of separate cylinder or cylinders for the recoil mechanism, it should be pointed out that the major forces, either that of the recoil force or the counter-recoil force or both, are applied at points which are off-set from the center line of the gun (or its axis of bore) and give rise to turning moments which tend to disturb the fire performance, aiming, the gun mounting, etc. It is a further object of this invention to devise a recoil mechanism which would eliminate the said disturbing moments.

The counter-recoil brake or buffer of the type of gun referred to is of the hydro type in which a fluid (usually oil) is employed to take up impact by its restricted displacement. A still further object of this invention is to devise an improved type of hydro counter-recoil mechanism.

For the attainment of these and such other objects of invention as may herein appear or be pointed out I have shown an embodiment of my invention in the accompanying drawing, wherein:

Figs. 1 and 1A are paired longitudinal sectional views through the breech end of a gun implemented with the improved recoil mechanism of this invention, the forward or muzzle part (leftward, in figures) appears in Fig. 1 and the rearward or breech part (rightward) appears in Fig. 1A.

Fig. 2 is an enlarged longitudinal section of a fragment of Fig. 1 and shows the counter-recoil mechanism in enlarged scale and in a different part of the cycle;

Fig. 3 is a cross-section on line 3—3 of Fig. 1;

Fig. 4 is an enlarged sectional detail of the counter-recoil valve mechanism of Fig. 2; and

Fig. 5 is a perspective view of a tube that cooperates with the piston to permit a greater or less amount of braking fluid to be displaced by the piston during its movement in its cylindrical casing.

The gun to which the improved recoil mechanism is applied is shown in the drawings as a tank-mounted gun, with the forward or muzzle end of its barrel 10 pointed leftwardly in Figs. 1 and 1A (being shown in Fig. 1; the breech or rear end being shown in Fig. 1A). Gun barrel 10 is slidable (to provide for recoil movement) within tube 1 which is mounted, as by flanged ring 2, to the shield or frame wall of the tank or turret.

According to this invention, a barrel sleeve 12 is secured to the outside of gun barrel 10, or rather to the breech yoke 19. For this reason the yoke is provided with a rabbetted mouth and the breech-end (right Fig. 1A) of barrel sleeve 12 is exteriorly threaded to receive a ring nut 19*a* disposed in the said rabbetted mouth of the yoke, and pinned (19*p*) to lock it against turning; the yoke itself is interiorly threaded to receive a second ring nut 19*b*. The barrel sleeve 12 slides on a pair of bronze bushings (soon described), but at this time it should be mentioned that the tank or turret tube 1 is provided with a pair of wiper rings 18 and 18' of felt or similar material to keep out dirt.

The barrel sleeve 12 is provided with two pistons, a main piston 13 which is shown in the figures as integral with the liner and a smaller piston 15, which is on a short sleeve 14 secured to sleeve 12 as by means of a keying ring 14*k*. It should be observed that neither piston 13 nor 15 are the usual type of piston occupying the entire cylinder cross section, but are ring pistons occupying only an annular space above the gun barrel. The larger ring piston 13 serves as the recoil piston while the smaller ring piston 15 serves as the counter-recoil piston (in a manner subsequently described), both moving together, as described.

Encircling gun barrel 10 is a cylinder jacket 20 which defines an annular space between itself and the gun barrel, within which is contained recoil spring 9 which is in helical form between

the recoil piston 13 and the rear or breech end (right, Fig. 1A) of cylinder 20, at which end cylinder 20 takes the form 21 shown in Fig. 1A. The cylinder 20 is hermetically sealed for reception of an incompressible fluid, usually oil; for this reason the cylinder jacket 20 makes a liquid-tight connection with the barrel sleeve 12.

The left end of cylinder jacket 20 is made fluid-tight in the following manner (Fig. 1): The afore-described tube 1 is provided at its right end (Fig. 1) with a rabbetted mouth within which is received the reduced left-end of an intermediate member 30 secured to the rear annular flange of the tube 1 in any convenient manner, as by a plurality of radiating lugs carried by said member and bolted to the flange. The right end of intermediate member 30 is provided with a rabbetted mouth as shown in Fig. 1 within which is received the left end of cylinder jacket 20; the right end of intermediate member 30 is also provided with a flange 30f. Near the left end of jacket 20 is welded a flange ring 20f, the two flanges 30f and 20f being bolted together and separated by an appropriate gasket. The right end of cylinder jacket 20, or rather its right end member 21, is made fluid-tight in the following manner (Fig. 1A): End member 21 is rabbet-mounted to receive a gland member 40 and is internally threaded for the exterior threads of the gland member. Between the rabbetted mouth of jacket member 21 and the reduced portion of gland member 40 is provided suitable packing material 41. Between gland member 40 and yoke 19 is provided a fiber ring 42 to take up the shock, especially on counter-recoil. The gland member 40 is provided with means for turning and adjustment, e. g., the notch or projection 43, Fig. 1A.

Gland member 40 also serves as a mounting for the bronze bushing 49 which is secured thereto as by pin 49p and which serves as the right-end slide bearing for barrel sleeve 12 in its recoil movement (rightwardly in Figs. 1–1A) and in its counter-recoil movement (leftwardly). The left-end bearing is a bronze bushing 59 secured, as by pin 59p to a gland member 50 associated with the aforementioned intermediate member 30, Fig. 1. Gland packing 51 is provided between the reduced portion of gland member 50 and intermediate member 30. Gland member 50 is secured and adjusted in intermediate member 30 by the screw connection shown.

The parts are shown in Fig. 1 in their normal position with the barrel assemblage—principally sleeve 12, recoil piston 13 and counter-recoil piston 15—in their leftmost position relative to the stationary parts of the gun mount—principally, the intermediate member 30. In this position of ring piston 13 (Fig. 1) in its cylinder 20, virtually all the oil (the fluid medium usually employed) will be to the right of the piston. On firing the gun, its projectile moving leftwardly (as viewed in Fig. 1), the barrel together with sleeve 12 and pistons 13 and 15 will move to the right in recoil direction. The rightward movement of ring piston 13 in its cylinder 20 forces the oil from the right side of the piston to its left, through one or more apertures provided in the piston or in the walls of the cylinder. The latter alternative is shown in the drawings and comprises an inner tube 22 provided with a slot or slots 22s of proper shape extending through its wall and tapering from a point near its forward end to a point near its opposite end.

Recoil piston 13 in moving rightwardly during recoil compresses spring 9, storing energy therein effective to return the gun (and the liner assemblage) leftwardly (counter-recoil direction). The counter-recoil brake or buffer diminishes the shock as the gun returns (leftwardly) to the firing position. The counter-recoil buffer of this invention comprises principally the aforedescribed ring piston 15 which functions within the annular space provided by a rabbetted mouth at the right end of intermediate member 30. At the beginning of counter-recoil, the parts including pistons 13 and 15, will be at their rightmost position, with virtually all of the oil to the left of piston 13. The leftward, return movement of the gun and the said parts forces the oil from the left side of the piston to its right (in opposite direction to that of oil movement during recoil); this oil movement, through the piston apertures or cylinder slots, will retard and ease the gun in its counter-recoil movement. To diminish the shock as the gun finally reaches and is stopped in its firing position, the said counter-recoil means functions as follows: The gun parts including the two pistons 13 and 15 are shown in Fig. 2 moving leftwardly and approach their leftmost position. During the major part of the movement of the gun and associated parts, the counter-recoil piston 15 performs no function, moving idly in the large cylinder 20. However, as the parts move leftwardly and near the end of their stroke, ring piston 15 enters the annular space provided by the aforedescribed rabbetted mouth at the right end of intermediate member 30, and traps a small portion of oil to the left of it.

The buffing effect is attained by throttling the oil as it is permitted to escape rightwardly as the leftward return of piston 15 continues. To further diminish the shock, the inner surface of said rabbetted mouth is beveled as designated at 35, Figs. 1 and 2. The member 30 is annular and is formed as a cup having a radial wall portion sealed with respect to the sleeve 12 by means of the gland 50 and packing 51. The member 30 further includes the annular portion that extends in the direction of the recoil of the gun and that surrounds the muzzleward end of the casing 20, being formed as aforesaid with the flange 30f. The interior portion of the member 30 is additionally formed with an annular portion surrounding the sleeve 12 within the muzzleward end of the casing 20 and this annular or cylindrical portion is formed as the section of a cone diminishing toward the muzzleward end of the gun. The interior conical surface of this last mentioned portion is designated by the numeral 35 and cooperates with the buffer piston 15 in the manner described below. It will be noted that the rabbetted mouth formed by the conical portion 35 provides an annular ring section separated from the main body of the member 30 by an annular groove in communication with a pair of diametrically opposed restrictive passages, or by-pass apertures, 31 which in turn communicate at the other side of the conical portion 35 with the interior of the casing 20. Two by-pass regulating valves 39 are provided respectively for the regulation of the flow of recoil fluid through the passages 31. Upon counterrecoil action of the gun, some of the oil or recoil fluid entrapped to the left of the counterrecoil piston 15 escapes between the edge of the piston 15 and the beveled mouth or conical section 35 and the remainder of this en-

trapped oil is forced through the passages 31. The buffing effect on counterrecoil may be adjusted by means of the by-passed regulating valves 39.

In the recoil stroke of the parts, rightward in the figures, provision is made for the oil to the right of the counter-recoil piston 15 to occupy the space to the left of the piston. It should be remembered that the entire annular space is completely filled with oil, hence provision must be provided to assure that the oil reaches all parts of that space. In the rightward (recoil) movement of piston 15, the oil will pass leftwardly over the edge of the piston (and through by-pass apertures 31), but this would impose an unnecessary resistance to the recoil movement and would interfere with the proper designed performance of the recoil piston 13 and its cooperative cylinder 20 and slots 22s. For this purpose, additional apertures 15a are provided in the counter-recoil piston 15 to permit this oil to by-pass leftwardly. The by-pass apertures 15a are closed during the counter-recoil stroke (leftward) although open during the recoil stroke (rightward). For this purpose a ring valve 5 is associated with piston 15 and placed to the left thereof and contained for a limited extent of axial movement between the piston and the key ring 14k, see Fig. 4. The piston is provided with a number of springs 16s which operate upon small plungers 16 to urge the ring member 5 leftwardly to open position. During the leftward, counter-recoil movement, the oil trapped to the left of piston 15 will cause the closing of the by-pass apertures 15a.

By reference to Fig. 5 it will be seen more clearly that the by-pass ports 22s in tube 22 are elongated and taper rearwardly so as to permit displacement of a greater amount of fluid past the piston in some positions of its stroke than in others. The result of this arrangement is that the gun is increasingly retarded as it nears the end of its recoil stroke and in its counter-recoil stroke its movement is equalized. For instance, at the start of the recoil stroke a greater amount of braking fluid can be displaced by the piston from the rear to its front side and the displacement decreases as the piston nears the end of the recoil stroke due to the narrowing of the by-pass port. On the other hand, when the piston nears the end of its counter-recoil stroke, and its spring is getting "weaker" more fluid, on account of the widening port, is by-passed from the front to the rear side of the piston.

I claim:

1. In a recoil mechanism for a gun, a gun barrel reciprocable in recoil and counter-recoil, a sleeve surrounding the rear portion of the barrel and secured thereto, a stationary cylindrical casing surrounding a portion of said sleeve spaced therefrom and forming therewith an elongated chamber closed at both ends for the reception of a braking fluid, a recoil piston fast to and surrounding the sleeve adjacent one end of the chamber and of less diameter than the chamber whereby fluid may pass from one side of the piston to the other upon the reciprocation of the piston, a recoil spring in said chamber surrounding the sleeve with one end in engagement with said piston and the other with the opposite end of the casing, a counter-recoil buffer piston carried by and surrounding the sleeve and of substantially less diameter than the chamber, a stationary ring coaxial with the sleeve and encircling the counter-recoil buffer piston and positioned to receive the counter-recoil piston to trap some of the braking fluid from said chamber upon the counter-recoil of the gun, and means in said stationary ring for by-passing the trapped fluid from said ring back to the chamber.

2. In a recoil mechanism for a gun, a gun barrel reciprocable in recoil and counter-recoil, a sleeve surrounding a portion of the barrel and secured thereto, a casing closed at both ends surrounding the sleeve and spaced therefrom to form an elongated chamber for the reception of a braking fluid, a recoil piston fast to and surrounding the sleeve adjacent the forward end of the chamber and of less diameter than the chamber, whereby fluid may pass from one side of said piston to the other upon the reciprocation of the piston, a recoil spring surrounding the sleeve between said piston and the opposite end of the casing, a counter-recoil buffer piston surrounding the sleeve in advance of the recoil piston and moving with said sleeve and of substantially less diameter than the chamber, said buffer piston being provided with a plurality of by-pass apertures, a stationary ring coaxial with the sleeve and encircling the counter-recoil buffer piston and positioned to receive the buffer piston to trap some of the braking fluid from said chamber upon counter-recoil of the gun, means in said stationary ring for by-passing the trapped fluid from said cylinder back to the chamber, and a floating ring surrounding the sleeve and carried by the buffer piston in advance of said piston to close said by-pass apertures in said piston during the counter-recoil movement of the gun.

3. The invention of claim 2 characterized in that there is means carried by the buffer piston to normally urge the floating ring to open position, comprising a plurality of spring-backed plungers in engagement with said ring, and means carried by the sleeve for limiting the forward movement of the ring.

4. In a recoil mechanism for a gun, a barrel reciprocable in recoil and counter-recoil, a casing surrounding the barrel and closed at both ends for hermetically inclosing a braking fluid, a recoil piston secured to the barrel and of less diameter than the interior of the casing so that fluid may pass the piston in its reciprocation in either direction, a recoil spring surrounding the barrel between the piston and one end of the casing, a buffer piston surrounding the barrel in advance of the recoil piston, a stationary open end cylinder surrounding the barrel in advance of the recoil piston and positioned to receive the buffer piston upon the counter-recoil stroke of the gun, and means for by-passing fluid forced from said cylinder by the buffer piston, back into the casing.

5. In a recoil mechanism for a gun, a support fixed against recoil, a gun tube carried by said support for recoil and counterrecoil, a casing for containing recoil fluid mounted on said support and arranged coaxial with and surrounding said gun tube, means closing one end of said casing, means closing the other end of said casing and including a cup-shaped member having a radial wall portion sealed in fluid-tight relationship with said gun tube and a coaxial annular portion extending within said casing in the direction of recoil of said gun tube and having its interior formed as the section of a cone diminishing in the direction of counterrecoil of said gun tube, a buffer piston formed as a ring surrounding and

secured to said gun tube within the casing normally in proximity to said cup-shaped member and cooperable with said cup-shaped member to trap recoil fluid in said cup-shaped member upon counterrecoil of said gun tube, and means including an adjustable restrictive passage in said cup-shaped member for effecting return of trapped recoil fluid from said cup-shaped member to said casing.

6. In a recoil mechanism for a gun, a support fixed against recoil, a gun tube carried by said support for recoil and counterrecoil, a casing for containing recoil fluid mounted on said support and arranged coaxial with and surrounding said gun tube, means closing one end of said casing, means closing the other end of said casing and including a cup-shaped member having a radial wall portion sealed in fluid-tight relationship with said gun tube and a coaxial annular portion extending within said casing in the direction of recoil of said gun tube, a buffer piston formed as a ring surrounding and secured to said gun tube within the casing normally in proximity to said cup-shaped member and cooperable with said cup-shaped member to trap recoil fluid in said cup-shaped member upon counterrecoil of said gun tube, and means including a restrictive passage in said cup-shaped member for effecting return of trapped recoil fluid from said cup-shaped member to said casing.

7. In a recoil mechanism for a gun, a support fixed against recoil, a gun tube carried by said support for recoil and counterrecoil, a casing mounted on said support coaxial with and surrounding said gun tube, means respectively at opposite ends of said casing for hermetically closing said casing at both ends to adapt said casing to contain recoil fluid, one of said closure means including a cup-shaped member within said casing having a radial wall portion surrounding said gun tube and a coaxial annular portion extending within said casing in the direction of recoil of said gun tube and having its interior formed as the section of a cone diminishing in the direction of counterrecoil of said gun tube, a buffer piston formed as a ring surrounding and secured to said gun tube within the casing normally in proximity to said cup-shaped member and cooperable with said cup-shaped member to trap recoil fluid in said cup-shaped member upon counterrecoil of said gun tube, and means including an adjustable restrictive passage in said cup-shaped member for effecting return of trapped recoil fluid from said cup-shaped member to within said casing.

8. In a recoil mechanism for a gun, a support fixed against recoil, a gun tube carried by said support for recoil and counterrecoil, a casing mounted on said support coaxial with and surrounding said gun tube, means respectively at opposite ends of said casing for hermetically closing said casing at both ends to adapt said casing to contain recoil fluid, one end of said closure means including a cup-shaped member within said casing having a radial wall portion surrounding said gun tube and a coaxial annular portion extending within said casing in the direction of recoil of said gun tube, a buffer piston formed as a ring surrounding and secured to said gun tube within the casing normally in proximity to said cup-shaped member and cooperable with said cup-shaped member to trap recoil fluid in said cup-shaped member upon counterrecoil of said gun tube, and means including a restrictive passage in said cup-shaped member for effecting return of trapped recoil fluid from said cup-shaped member to said casing.

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