Nov. 30, 1948. V. F. LUCHT 2,454,818

GUN RECOIL SPRING SURGE DAMPENER

Filed March 7, 1946 3 Sheets-Sheet 1

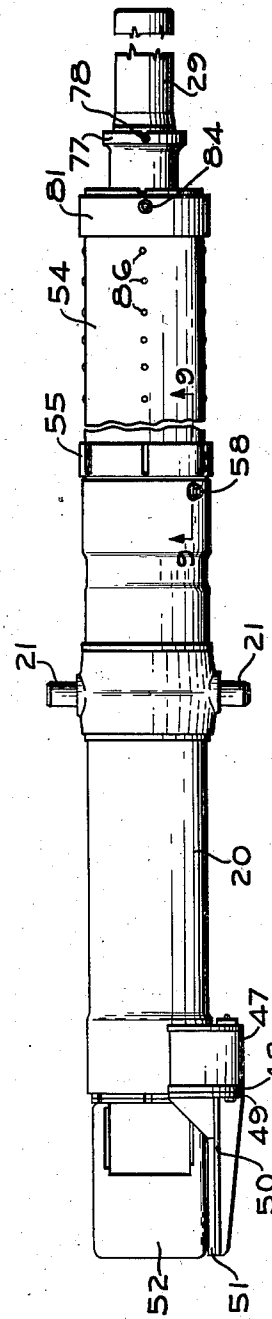


FIG-1

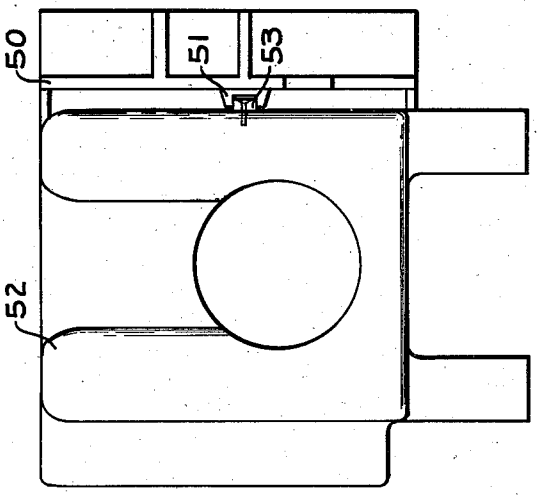


FIG-5

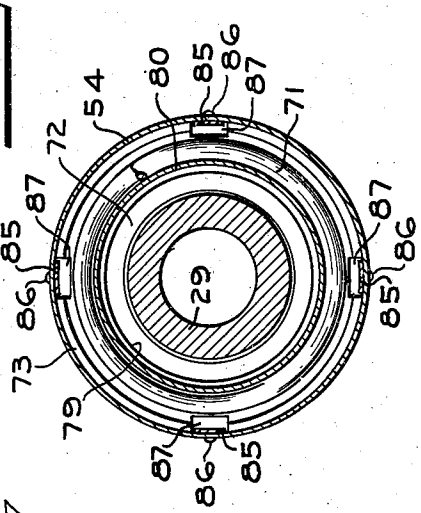


FIG-4

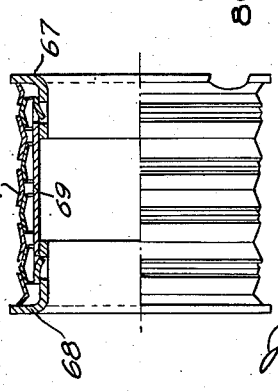


FIG.12

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GUN RECOIL SPRING SURGE DAMPENER

Filed March 7, 1946 3 Sheets-Sheet 2

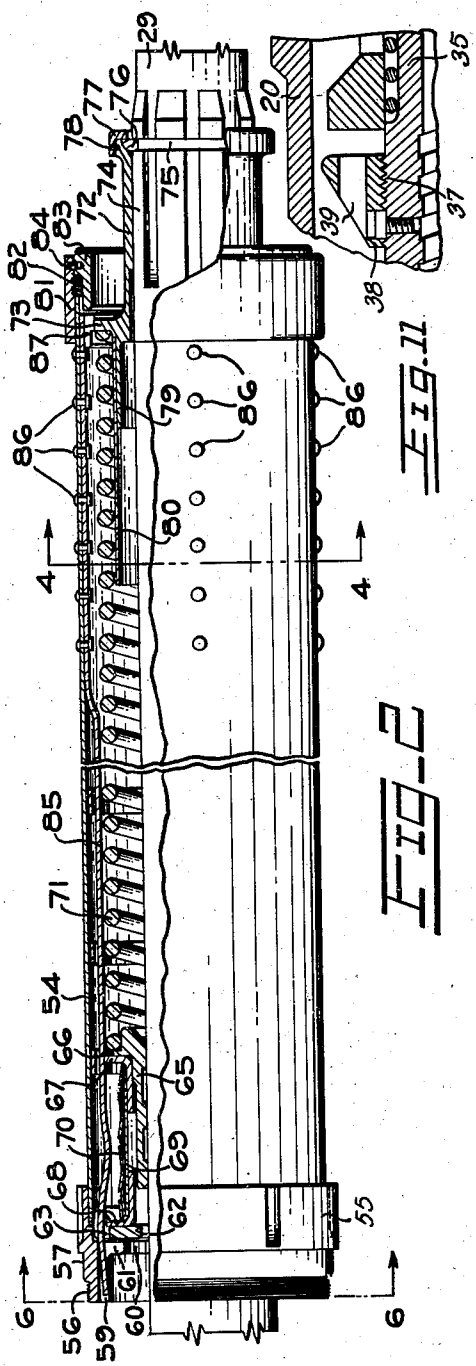


Fig. 2

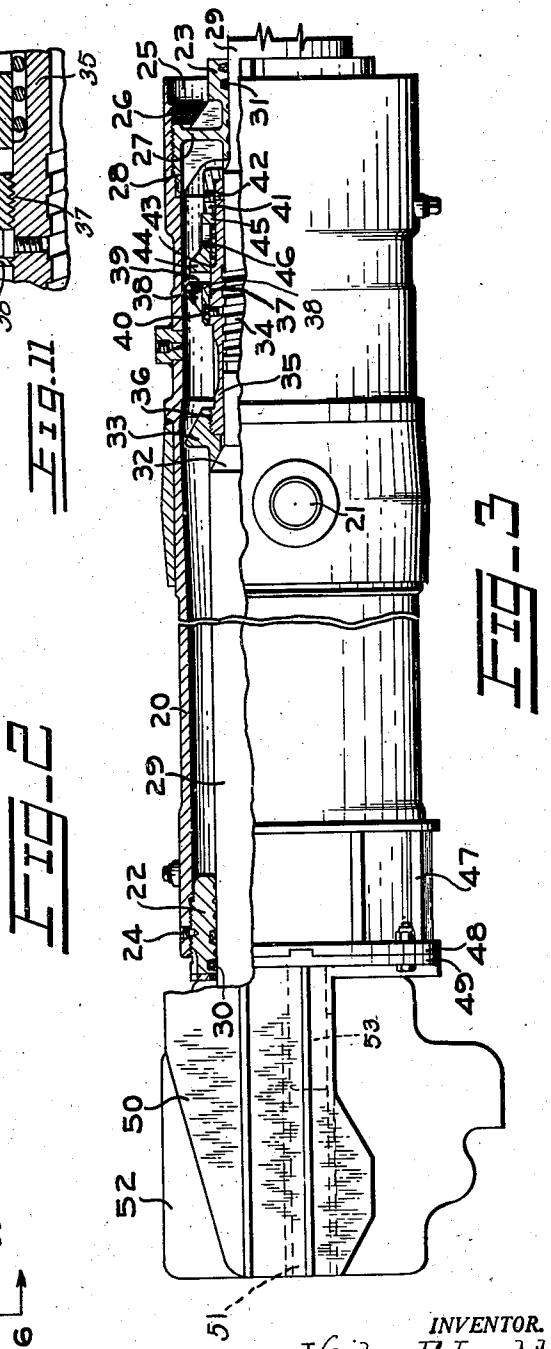


Fig. 3

Fig. 11

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GUN RECOIL SPRING SURGE DAMPENER

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FIG_6

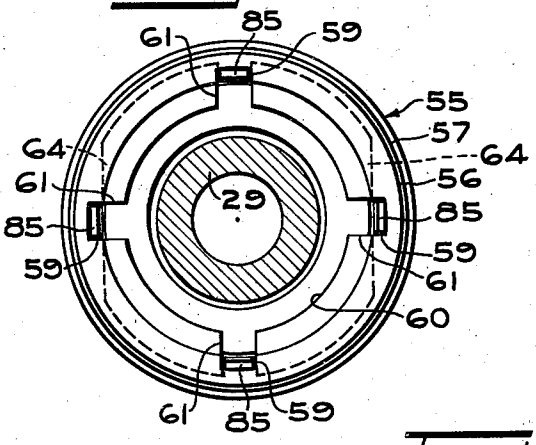


FIG_7

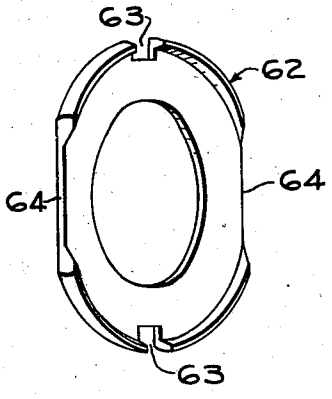
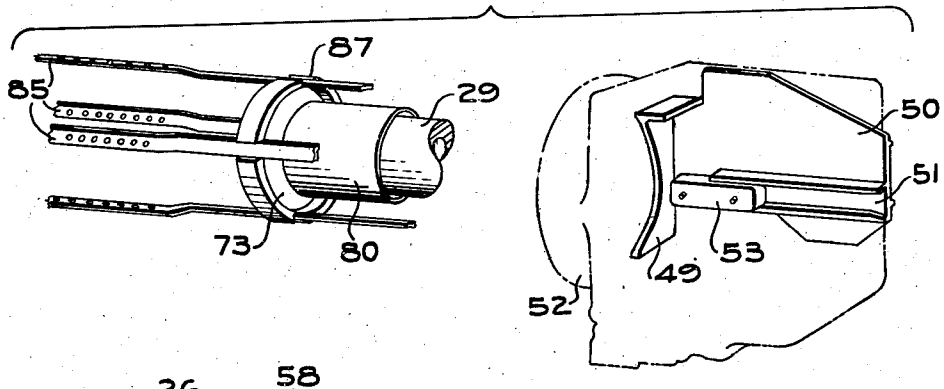


FIG_8



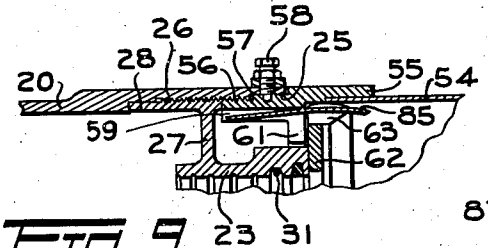


FIG_9

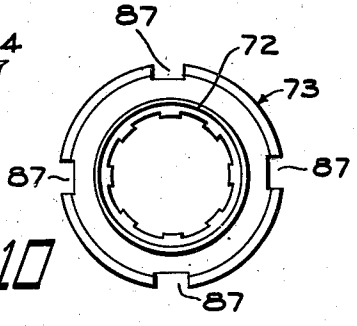


FIG_10

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2,454,818

GUN RECOIL SPRING SURGE DAMPENER

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Application March 7, 1946, Serial No. 652,754

8 Claims. (Cl. 89—44)

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

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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 to recoil mechanisms for guns. More particularly, the invention relates to improvements in recoil mechanisms of the type in which the recoil cylinder encloses and is concentric with the gun tube.

As is well known to those skilled in the art, the recoil mechanism in an artillery piece is subjected to forces and shocks of tremendous magnitude. In the so-called hydro-spring type of recoil mechanism a powerful coil spring is compressed by recoil action of the gun and the energy stored therein is utilized to return the gun tube to battery. It has been found that springs used in this type of recoil mechanism sometimes fail prematurely because of uncontrolled action thereof in compression and extension. In addition, the uncontrolled action of the spring interferes with smooth operation of the gun. This defect will be experienced in weapons in which the recoil mechanism is separate from and parallel to the gun tube as well as in weapons in which the recoil mechanism is disposed concentrically with the gun tube.

As is particularly the case in a recoil mechanism of the concentric type, some difficulty has been experienced in restraining the gun tube against a twisting action that results from the torque developed in the tube when the projectile travels through the rifled barrel. In the ordinary type of recoil mechanism, sufficient structure is provided in the form of the cradle or sleigh to accommodate means for restraining the gun tube against the action resulting from this torque. In the case of a concentric recoil mechanism, the arrangement is more compact and the problem of guiding the gun tube and restraining the tube against twisting is somewhat more difficult. In the past, this problem has been solved only by means of additional structure at the breech end of the weapon. The presence of such additional structure is not always desirable, since it increases the overall length of the weapon and renders more difficult the adaptation of the weapon to use in aircraft or tanks or other armored vehicles.

According to the present invention, means are provided for controlling undesirable action of the counterrecoil spring as the spring is compressed and extended upon recoil and counterrecoil of the gun. This means particularly controls "surging" of the spring. "Surging" of the

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spring occurs upon initial rapid compression of the spring and the coils at one end of the spring become grouped and impart longitudinal forces to adjacent coils which likewise become grouped; coils so grouped impart similar forces successively along the spring with the result that the force built up prior to complete compression of the spring attains such magnitude that a reaction is set up and the forces and shocks travel toward the other end of the spring and thence back and forth from one end of the spring to the other. It will be appreciated that surging occurs so rapidly that undesirable vibration can occur before the spring reaches the limit or its compression and in many cases results in premature fatiguing or even destruction of the spring.

It is accordingly a principal object of the present invention to provide means for damping or otherwise controlling the action of a spring so that surging of the spring is eliminated or kept to a minimum.

It is an important object of the invention to provide such means as a component for the counterrecoil spring of the recoil mechanism of an artillery weapon.

Another important object of the invention is to provide such means in a recoil mechanism of the type in which both the recoil chamber and the counterrecoil spring are concentric with the gun tube.

The invention has for another object the provision of a shock-absorbing means for the counterrecoil spring of a recoil mechanism; and another object is to combine the shock-absorbing means with the surge-damping means so that operation of the recoil mechanism is accomplished more smoothly and efficiently.

It is another object of the invention to provide damping means in the form of a plurality of resilient elements that extend longitudinally of the spring outside the coils thereof.

Yet another object is to provide means on the gun tube and cooperable with the resilient element for absorbing the torque imparted to the gun barrel by a projectile fired therefrom.

And still another object of the invention is to provide an improved recoil mechanism including second guide means for restraining the gun tube against the twisting action that occurs when the gun is fired.

The foregoing and other important objects and features of the invention may be had from the following detailed description and accompanying sheets of drawings in which:

Fig. 1 is a plan view of a gun embodying a preferred form of the invention;

Fig. 2 is an enlarged forward or muzzleward portion of the weapon, partly in section, and illustrating the counterrecoil spring and associated components;

Fig. 3 is a view of the rear or breech portion of the weapon, the view being partly in section and showing the construction of the recoil cylinder; the views of Figs. 2 and 3 may be assembled by placing Fig. 2 at the right-hand end of Fig. 3;

Fig. 4 is a transverse sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a view taken from the breech end of the weapon and showing one of the guide means for absorbing torque imparted to the gun tube by a projectile fired from the gun;

Fig. 6 is a transverse sectional view taken substantially on the line 6—6 of Fig. 2;

Fig. 7 is a perspective view of the rear retaining ring for the surge-damping means;

Fig. 8 is a diagrammatic perspective view illustrating the manner in which the first and second, or primary and auxiliary, guide means function to restrain the gun tube against twisting;

Fig. 9 is a fragmentary longitudinal sectional view taken on the line 9—9 of Fig. 1 illustrating the manner in which the counterrecoil spring housing or sleeve is secured to the recoil cylinder; and

Fig. 10 is an end view of the member that serves as a guide for restraining the gun tube against twisting as well as a means for retaining one end of the counterrecoil spring.

Figure 11 is an enlarged fragmentary sectional view showing the relationship between the buffer piston and the cylinder,

Figure 12 is an enlarged end, partly in section, of the ring springs assembly.

Although the preferred form of the invention has been illustrated herein in connection with a recoil mechanism of the concentric type, it will be appreciated that several of the features thereof are similarly applicable to recoil mechanisms of other types. Accordingly, the description and drawings should be taken as illustrative and not limiting.

In the type of weapon illustrated and described herein, the support for the gun comprises a cylindrical housing or cradle 20 formed at an exterior portion thereof intermediate its ends with a pair of oppositely extending trunnions 21. These trunnions adapt the gun for mounting in aircraft, carriages, or tanks and other armored vehicles. The cylindrical housing 20 takes the place of the cradle assembly that characterizes weapons of the type in which the gun tube and recoil mechanism are not concentric. As best shown in Fig. 3, the cylindrical housing is provided at opposite ends with interior annular bearings 22, at the breech or rear end, and 23, at the muzzleward or forward end. The bearing 22 is threaded into the threaded rear end of the housing or cylinder 20 and is retained therein by a retaining screw 24. The forward end of the cylinder 20 is provided with a concentric annular recess 25 and, adjacent this recess and concentric therewith, is internally threaded as at 26. The bearing 23 comprises a sleeve which serves as the bearing and on which is formed an integral annular rib or flange 27. A circumferential flange 28 is formed integral with the rib 27 and is externally threaded to fit the internal threads 26 in the cylinder 20.

The gun tube or barrel of the weapon, indicated by the numeral 29, is carried for recoil and counterrecoil by the bearings 22 and 23. The bearings 22 and 23 include fluid-tight seals 30 and 31, respectively. Thus the cylinder 20 is adapted to contain recoil oil or other suitable fluid in the annular chamber provided between the outer cylindrical surface of the tube 29 and the inner cylindrical surface of the cylinder. The tube 29 is formed intermediate its ends within the cylinder 20 with a conical seat 32. A recoil piston means in the form of a ring 33 is provided with an internal conical seat complementary to the seat 32. That portion of the gun tube forwardly of the seat 32 is preferably formed with a series of square threads 34. An internally threaded sleeve 35 is carried on the tube 29 by the threaded portion 34 and has its rearward end externally threaded to engage an internally threaded portion of the recoil piston 33 as at 36. An intermediate portion of the sleeve 35 is externally threaded at 37 and carries a buffer piston in the form of a ring 38. This ring is provided with a plurality of circumferentially spaced, axially directed bores 39 (only one of which is shown) and is held against rotating on the sleeve 35 by means of a locking screw 40. The forward end of the sleeve 35 is externally threaded and carries a retaining cap 41. This cap is held against rotation with respect to the sleeve 35 by means of a locking screw 42. That portion of the sleeve 35 between the buffer piston 38 and cap 41 is annularly reduced and there is thus formed on the sleeve 35 an annular shoulder 43. Valve means in the form of a ring 44 is carried by the sleeve 35 and is axially shiftable between the buffer piston 38 and the cap 41. The forward end of the valve ring 44 is formed with a radially inwardly directed annular flange 45. A coil spring 46 encircles the reduced portion of the sleeve 35 and is confined between the annular shoulder 43 on the sleeve 35 and the annular flange 45 on the valve ring 44. The action of the spring 46 is such that the valve ring 44 is normally maintained in the position shown in Fig. 3.

The cylinder 20 is provided at its breech end with mounting structure 47 including a rear flange 48 to which is rigidly attached a vertical flange 49 on a rearwardly extending guide plate 50. As best shown in Figs. 5 and 8, the inner face of the guide plate 50 is formed with a longitudinal channel or groove 51. The gun tube 29 extends breechwardly through the rear bearing 22 of the cylinder 20 and carries rigidly thereon a breech ring 52. The right-hand side of the breech ring (as viewed from a position behind the gun) carries rigidly thereon a guide element 53. As shown in Figs. 5 and 8, the guide element 53 slidably engages the channel 51 in the guide plate 50. Thus, as the gun tube recoils and counterrecoils, the guiding components 51 and 53 prevent twisting of the gun tube in response to torque imparted by the projectile as it travels through and leaves the rifled tube.

The recoil mechanism, of which the cylinder 20 forms a part, is completed by counterrecoil mechanism which is disposed coaxially with the cylinder 20, or concentrically of the gun tube 29, and which is contained in a second cylinder or sleeve 54. This sleeve is preferably formed of sheet metal construction and, as shown in Figs. 2 and 9, has rigidly secured to its rear or breechward end a mounting ring 55, the extreme rear end of which is reduced and threaded as at 56.

An annular seat 57 is provided on the ring adjacent the threaded portion 56. The sleeve 54 is removably carried by the cylinder 20 and, when the parts are assembled, the threaded portion 56 of the sleeve fits the internally threaded portion 26 of the cylinder and the annular seat 57 fits the annular internal recess 25 of the cylinder. The sleeve 54 is secured against rotation with respect to the cylinder 20 by means of a locking screw 58 which is threaded through a section of the wall of the cylinder 20 and engages a portion of the annular seat 57 on the mounting ring 55 of the sleeve 54 (Fig. 9).

The interior of the mounting ring 55 is formed with a plurality of longitudinally directed, circumferentially spaced slots 59. The ring is further formed with an internal integral annular rib 60 which includes a plurality of slots 61 coincident with the slots 59 (Fig. 6). A retainer ring 62 (Fig. 7) encircles the gun tube 29 and is positioned just forwardly of the annular wall or rib 60 in the mounting ring 55. The ring 62 is provided with a pair of diametrically opposed slots 63 and the diametrically opposed other sides of the ring are flattened, as at 64 (Fig. 7). When the parts are assembled, the slots 63 are respectively aligned with the upper and lower slots 59 in the mounting ring 55 and the flat sides 64 lie respectively radially inwardly of the slots 59 at opposite sides of the mounting ring 55 (Fig. 6). The body portion of the ring 62 abuts the radial face at the forward end of the tube-supporting bearing 23 (Fig. 9).

A bearing sleeve 65 encircles that portion of the gun tube 29 just forwardly of the ring 55 and carries the gun tube for recoil and counterrecoil. The sleeve 65 includes an external annular radial flange 66 against the rear face of which is seated a flanged ring 67. A similar ring 68, opposed to the ring 67, seats against the front radial face of the ring 62. A sleeve 69 surrounds the cylindrical portions of the rings 67 and 68, and a plurality of ring springs 70 encircles the sleeve 69 between the radially flanged portions of the rings 67 and 68. The unit comprising the rings 67 and 68, the sleeve 69, and the ring springs 70 provides shock absorbing means for receiving one end of a coil spring 71, the rear end of the spring seating against the radial flange 66 on the bearing sleeve 65.

The forward end of the spring 71 is seated against a guide member 72, an annular radial wall 73 being formed as an integral part thereof to receive or pilot the end of the spring. The guide 72 is internally splined (Fig. 10) and is carried on an externally splined portion 74 of the gun tube 29 (Fig. 2). The forward end of the spline 74 on the gun tube 29 terminates in an annular groove 75 formed in the gun tube 29. A split ring 76, preferably comprising two semicircular halves, is contained by the groove 75 and is recessed in the forward end of the guide member 72. That portion of the guide 72 that surrounds the split ring 76 is externally threaded and receives a nut 77. A locking pin 78 secures the nut 77 against rotation with respect to the guide 72. The guide member 72 includes at its rearward end an integral sleeve portion 79 which encircles the gun tube 29 and to which is rigidly secured a tubular extension 80. The extension 80 serves to retain or pilot the forward end of the counterrecoil spring 71.

In order that the components of the counterrecoil mechanism—including the rings 62, 67, 68, sleeve 69, bearing sleeve 65 and spring 71—may

be easily assembled and disassembled, the forward end of the sleeve 54 is provided with an external ring 81. This ring is rigidly secured to the sleeve 54, as by welding, and is internally threaded at 82. An internal nut 83, formed as a ring encircling a portion of the guide member 72, is threaded into the threaded portion 82 of the ring 81 and is held therein against rotation by a locking pin 84.

The threaded portion 82 of the ring 81 is substantially twice as long as the threaded portion of the nut 83. When the mechanism is assembled, the components of the shock-absorbing unit are inserted first, followed by the spring 71 and guide 72. The nut 83 is then threaded into the ring 81 and turned in until it engages the radial wall portion 73 of the guide 72. This procedure compresses the spring 71 and moves the guide 72 a sufficient distance rearwardly on the gun tube 29 to expose the split ring groove 75. The split ring 76 is then fitted into the groove 75 and the nut 83 is backed off to the position shown in Fig. 2. The compression or load of the spring 71 is then taken by the gun tube 29 through the guide 72 and the split ring 76. The nut 77 is threaded onto the guide 73 and is locked in place by the pin 78. The procedure just described is reversed when the mechanism is disassembled. In short, in disassembly, the ring 83 is turned in until the split ring 76 is relieved of the load of the spring 71 and the ring 76 is subsequently removed.

As stated previously, it has been found that uncontrolled surging of the counterrecoil spring interferes with the smooth and efficient operation of the recoil mechanism. According to the present invention means are provided for damping the surging action of the counterrecoil spring 71. In its preferred form, this means comprises a plurality of longitudinally running resilient members in the form of leaf springs 85 spaced circumferentially about the interior of and rigidly secured to the sleeve 54, as by rivets 86. These leaf springs extend substantially throughout the length of the sleeve 54 and have their free ends inserted through and retained by the slots 59 in the mounting ring 55. In the present instance, there are four such springs 85. The upper and lower springs pass through the peripheral slots 63 in the retaining ring 62 and the springs at the right-hand and left-hand sides of the unit pass alongside the diametrically opposed flat sides 64 on the ring 62. The rearward half of each spring 85 is curved inwardly and then longitudinally so that it lies in close proximity to the outside diameter of the counterrecoil spring 71. The relationship between the spring 71 and the damper springs 85 is such that frictional engagement between the two occurs when the former is compressed upon recoil of the gun tube 29. The tendency of the coils of the spring to group and impart successive impulses to adjacent coils is restrained because of the action of the damper springs 85. In other words, as the coils at the forward end of the spring 71 tend to come together upon initial compression of the spring when the gun tube recoils, the collection of forces normally resulting from such action is counteracted by the rearward portions of the springs 85. Whereas, heretofore, the successively grouped coils would rebound back and forth from one end of the spring to the other, such rebounding is now inhibited by the damper springs 85, since, as the continuously enlarging group of coils reaches the rearward portions of the leaf springs 85, it is retarded and by the time the forces resulting from

the piled up coils at the forward end of the spring reach the rearward end of the spring, the gun tube has recoiled sufficiently to compress the spring to its maximum extent, at which point the spring 71 is fairly well "packed" and inherently resists surging.

Another important feature of the invention is the cooperation between the guide member 72 and the guide elements 51 and 53 previously described. The guide member 72 (Fig. 10) is provided about its periphery with four equally spaced notches or slots 87. The notches 87 are designed to cooperate with the damper springs 85 and provide complementary guide elements. The notches 87 are sufficiently deep to accommodate the inwardly directed rearward portions of the springs 85 so that the guiding action is secured throughout the recoil and counterrecoil strokes.

The travel of the gun tube in recoil is substantially twice as long as the length of the channel 51 on the rear guide plate 50. Hence the guide plate 50 will serve to prevent twisting of the gun tube only during substantially the first half of the recoil action, after which the guide 53 on the breech ring 52 will escape the channel 51. However, the gun tube is still held against twisting by means of the action of the guide 72 and damper springs 85. In short, the guiding action of the guide elements 50 and 51 is supplemented by the guiding action between the guide 72 and damper springs 85. Because of the high initial torque developed when the projectile is fired, it is desirable to include the guiding elements 50 and 51 rather than to depend on the guide 72 alone. On the other hand, the ability of the guide 72 to function as described permits economy in material and space, since the length of the guide plate 50 can be substantially reduced.

Operation

When the weapon is fired and the gun tube recoils, the recoil piston 33 is forced rearwardly against the resistance of recoil oil contained in the cylinder 20. This oil is then forced from the rearward side of the piston 33 to the forward side thereof and a throttling action is effected as the oil escapes through the spaces between the edges of the pistons 33 and 35 and the inner cylindrical surface of the cylinder 20, and thence through the bores or ports 39. When the gun tube recoils, the counterrecoil spring 71 is compressed. The initial shock is absorbed by the ring springs 70 and surging of the spring 71 is prevented by action of the damper springs 85, as previously described. The tendency of the gun tube to twist as the projectile is fired is resisted by action of the guide 53 on the breech ring 52 and channel 51 on the guide plate 50. As the gun tube continues to recoil, the spring 71 is more fully compressed. The guide 53 on the breech ring 52 will escape the channel 51 in the guide plate 50. However, the tendency of the tube to twist is still resisted by the cooperation between the guide 72 and damper springs 85. As the gun tube reaches its maximum recoiled position, the counterrecoil spring 71 will be compressed to its maximum extent. The tendency of the spring to "pack" will be alleviated by the ring springs 70 and there will be no violent shock. Reaction of the counterrecoil spring 71 will now return the gun tube to battery, during which phase of operation the recoil oil that is now at the front side of the piston will be forced to the rear side thereof. The presence of the oil at the front side of the chamber in the cylinder 20 will cause the valve ring 44 to move rearwardly against the action of the valve spring 46 and to close the bores or ports 39 in the buffer piston 38. Consequently, the gun tube 29 returns to battery smoothly and easily. During travel of the gun tube in recoil, the valve ring 44 remains open, partly by action of the valve spring 46 and partly because of pressure of recoil oil as the oil is forced through the bores 39 in the buffer piston 38.

One of the more important features of the invention, in addition to the structure and function of the surge-damping means and the means for preventing twisting of the gun tube, is the mounting of the recoil piston 33 directly on the gun tube 29. In concentric recoil mechanisms of the type heretofore known, the recoil piston was mounted on a sleeve which in turn was connected to the breech end of the gun tube. The recoil cylinder formerly included an intermediate sleeve portion which supported the gun tube for movement in recoil and counterrecoil. According to the present invention, this expensive and additional structure is eliminated and the entire mechanism is simplified.

Still another feature incidental to the present invention is the location of the counterrecoil spring coaxial with and outside the recoil cylinder 20. In earlier types of recoil mechanisms, whether of the concentric or eccentric type, it was customary to house the counterrecoil spring within the recoil cylinder. That design required a recoil of increased length. According to the present invention the length of the recoil cylinder 20 has been shortened. The location of the spring 71 forwardly of the cylinder 20 does not undesirably increase the dimensions of the weapon, since the portion of the tube encircled by the spring 71 otherwise has no particular function in connection with operation of the recoil mechanism.

Other features of perhaps lesser importance will be apparent to those skilled in the art. It will be understood, of course, that the form of the invention illustrated and described herein is a preferred embodiment and that numerous modifications and alterations may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. In a recoiling gun, a cylindrical cradle fixed against recoil and counterrecoil and provided with interior bearing elements, a gun tube mounted concentrically within said cradle and slidably carried by said bearing elements for recoil and counterrecoil, a breech ring on said gun tube, a support fixedly mounted on said cradle and extending breechwardly alongside said breech ring, first cooperable guide elements carried respectively by said breech ring and said support and relatively slidable in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube on its axis with respect to said cradle, the breechward extent of the interlocking effectiveness of said guide elements being less than the length of the recoil stroke of said gun tube, and second cooperable guide elements carried respectively by said gun tube and said cradle muzzlewardly of said first guide elements and relatively slidable in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube about its axis with respect to said cradle, said second guide elements being arranged to take effect prior to the end of the effectveness of said first guide elements and to continue effective during completion of the recoil stroke.

2. In a recoiling gun, a gun cradle fixed against

recoil and counterrecoil, a gun tube slidably carried by said cradle for recoil and counterrecoil, a breech ring on said gun tube, a support fixedly mounted on said cradle and extending breechwardly alongside said breech ring, first cooperable guide elements carried respectively by said breech ring and said support and relatively slidable in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube on its axis with respect to said cradle, the breechward extent of the interlocking effectiveness of said guide elements being less than the length of the recoil stroke of said gun tube, and second cooperable guide elements carried respectively by said gun tube and said cradle muzzlewardly of said first guide elements and relatively slidable in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube about its axis with respect to said cradle, said second guide elements being arranged to take effect prior to the end of the effectiveness of said first guide elements and to continue effective during completion of the recoil stroke.

3. In a recoiling gun, a cylindrical cradle fixed against recoil and counterrecoil and provided with interior bearing elements, a gun tube mounted concentrically within said cradle and slidably carried by said bearing elements for recoil and counterrecoil, a breech ring on said gun tube, a support fixedly mounted on said cradle and extending breechwardly alongside said breech ring, main cooperable guide elements carried respectively by said breech ring and said support and relatively slidable in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube on its axis with respect to said cradle, the breechward extent of the interlocking effectiveness of said guide elements being less than the length of the recoil stroke of said gun tube, a sleeve fixed on said cradle concentric therewith at its muzzleward end encircling said gun tube, a first auxiliary guide member carried by said sleeve, a second auxiliary guide member carried by said gun tube and positioned with respect to and for cooperation with said first guide member for relative sliding movement in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube on its axis with respect to said cradle, said auxiliary guide members being arranged to take effect prior to the end of the effectiveness of said first guide elements and to continue effective during completion of the recoil stroke.

4. In a recoiling gun, a gun cradle fixed against recoil and counterrecoil, a gun tube slidably carried by said cradle for recoil and counterrecoil, a support fixedly mounted on said cradle and extending breechwardly alongside said breech ring, first cooperable guide elements carried respectively by said breech ring and said support and relatively slidable in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube on its axis with respect to said cradle, the breechward extent of the interlocking effectiveness of said guide elements being less than the length of the recoil stroke of said gun tube, a sleeve fixed on said cradle concentric therewith at its muzzleward end and encircling said gun tube, a first auxiliary guide member carried by said sleeve, a second auxiliary guide member carried by said gun tube and positioned with respect to and for cooperation with said first guide member for relative sliding movement in the directions of recoil and counterrecoil but interlockable against twisting of said gun tube on its axis with respect to said cradle, said auxiliary guide members being arranged to take effect prior to the end of the effectiveness of said first guide elements and to continue effective during completion of the recoil stroke.

5. In a recoiling gun, a cylindrical cradle fixed against recoil and counterrecoil and provided with interior bearing elements, a gun tube mounted concentrically within said cradle and slidably carried by said bearing elements for recoil and counterrecoil, a breech ring on said gun tube, a support fixedly mounted on said cradle and extending breechwardly alongside said breech ring, first cooperable guide elements carried respectively by said breech ring and said support and relatively slidable in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube on its axis with respect to said cradle, the breechward extent of the interlocking effectiveness of said guide elements being less than the length of the recoil stroke of said gun tube, a coiled compression spring encircling said gun tube at a portion of said cradle muzzlewardly of said breech ring, means on said cradle against which one end of said spring abuts, an abutment secured to said gun tube and abutting the other end of said spring for compression of said spring during recoil of the gun tube, and second guide elements respectively on said sleeve and said abutment and cooperable for relative sliding in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube on its axis with respect to said cradle, said second guide elements being arranged to take effect prior to the end of the effectiveness of said first guide elements and to continue effective during completion of the recoil stroke.

6. In a recoiling gun, a gun cradle fixed against recoil and counterrecoil, a gun tube slidably carried by said cradle for recoil and counterrecoil, a breech ring on said gun tube, a support fixedly mounted on said cradle and extending breechwardly alongside said breech ring, first cooperable guide elements carried respectively by said breech ring and said support and relatively slidable in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube on its axis with respect to said cradle, the breechward extent of the interlocking effectiveness of said guide elements being less than the length of the recoil stroke of said gun tube, a coiled compression spring encircling said gun tube muzzlewardly of said breech ring, means on said cradle against which one end of said spring abuts, an abutment secured to said gun tube and abutting the other end of said spring for compression of said spring during recoil of the gun tube, and second guide elements respectively on said sleeve and said abutment and cooperable for relative sliding in the directions of recoil and counterrecoil but interlockable against twisting of said gun tube on its axis with respect to said cradle, said second guide elements being arranged to take effect prior to the end of the effectiveness of said first guide elements and to continue effective during completion of the recoil stroke.

7. In a recoiling gun, a cylindrical cradle fixed against recoil and counterrecoil and provided with interior bearing elements, a gun tube mounted concentrically within said cradle and slidably carried by said bearing elements for recoil and counterrecoil, a breech ring on said gun tube, a support fixedly mounted on said cradle

and extending breechwardly alongside said breech ring, first cooperable guide elements carried respectively by said breech ring and said support and relatively slidable in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube on its axis with respect to said cradle, the breechward extent of the interlocking effectiveness of said guide elements being less than the length of the recoil stroke of said gun tube, a sleeve fixed on said cradle concentric therewith at its muzzleward end and encircling said gun tube, a coiled compression spring encircling said gun tube and enclosed by said sleeve at a portion of said cradle muzzlewardly of said breech ring, means on said cradle against which one end of said spring abuts, an abutment secured to said gun tube and abutting the other end of said spring for compression of said spring during recoil of the gun tube, a plurality of leaf springs carried by said sleeve at its interior and extending muzzlewardly and engageable with said coil spring to dampen surging thereof, and a guide on said sleeve and cooperable with said leaf springs for relative sliding in the directions of recoil and counterrecoil but interlockable against twisting action of said gun tube on its axis with respect to said cradle, said abutment and leaf springs being arranged to take effect prior to the end of the effectiveness of said first guide elements and to continue effective during completion of the recoil stroke.

8. In a recoiling gun, a cylindrical cradle fixed against recoil and counterrecoil and provided with interior bearing elements, a gun tube mounted concentrically within said cradle and slidably carried by said bearing elements for recoil and counterrecoil, a breech ring on said gun tube, a sleeve fixed on said cradle concentric therewith at its muzzleward end and encircling said gun tube, a coiled compression spring encircling said gun tube and enclosed by said sleeve at a portion of said cradle muzzlewardly of said breech ring, means on said cradle against which one end of said spring abuts, an abutment secured to said gun tube and abutting the other end of said spring for compression of said spring during recoil of the gun tube, a plurality of leaf springs carried by said sleeve at its interior and extending muzzlewardly and engageable with said coil spring to dampen surging thereof, and a guide on said sleeve and cooperable with said leaf springs for relative sliding in the directions of recoil and counterrecoil but interlockable against twisting of said gun tube on its axis with respect to said cradle.

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