

[54] RECOIL ABSORBER
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3,390,709	7/1968	Schmidt.....	267/147
2,962,935	12/1960	Hepperle	89/198
3,171,326	3/1965	Baker.....	89/177
3,115,063	12/1963	Browning.....	89/177
2,869,858	1/1959	Hartwell	267/147

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89/198; 188/70 R, 70 B, 136; 267/147

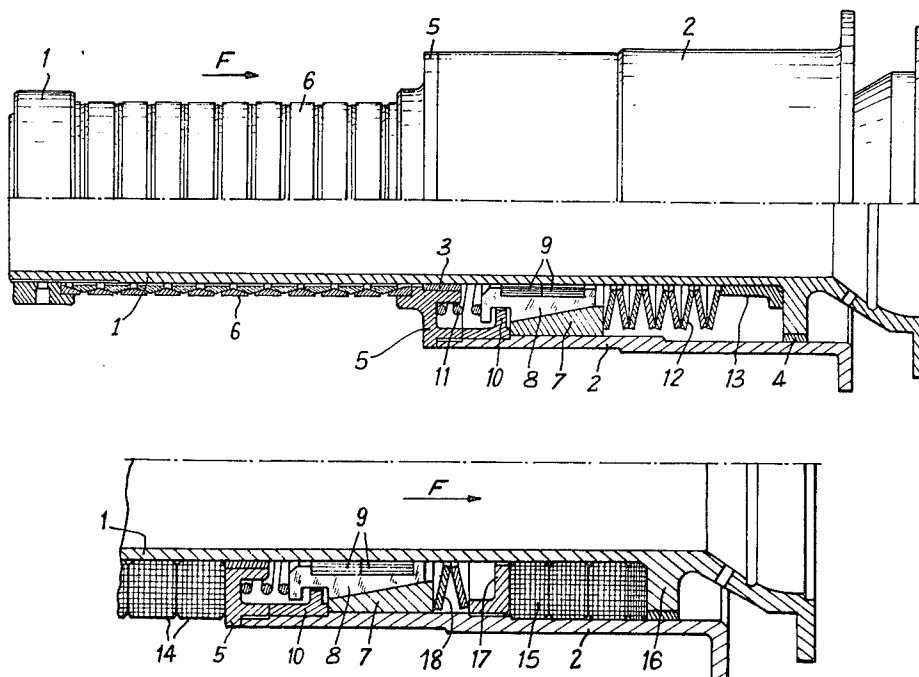
[56] References Cited
UNITED STATES PATENTS

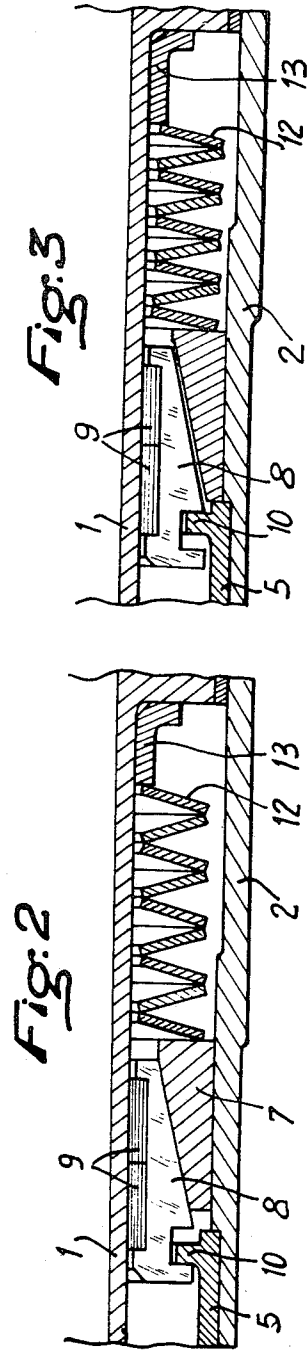
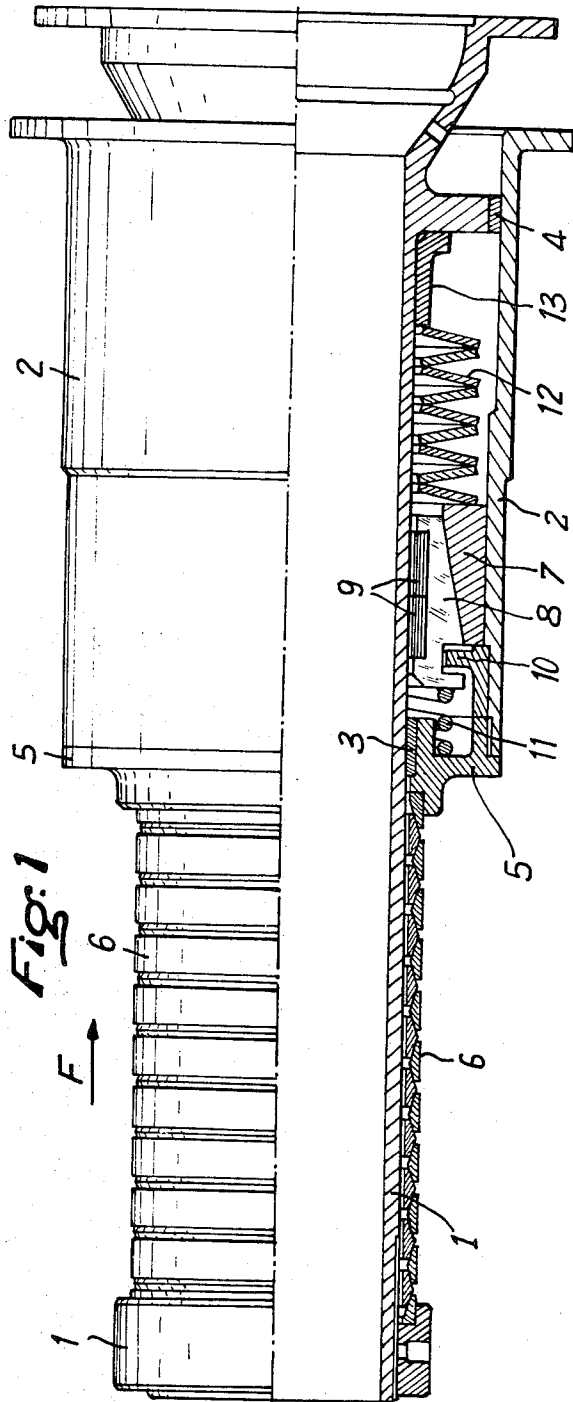
2,539,275 1/1951 Sahlin et al. 89/44

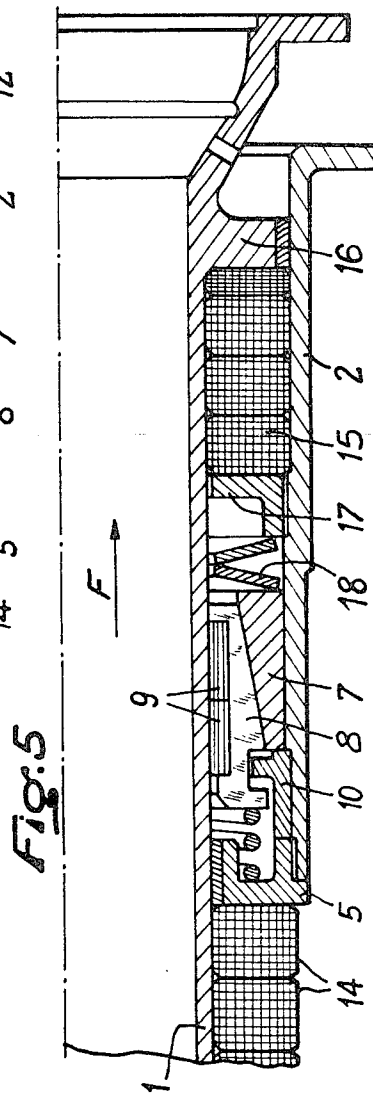
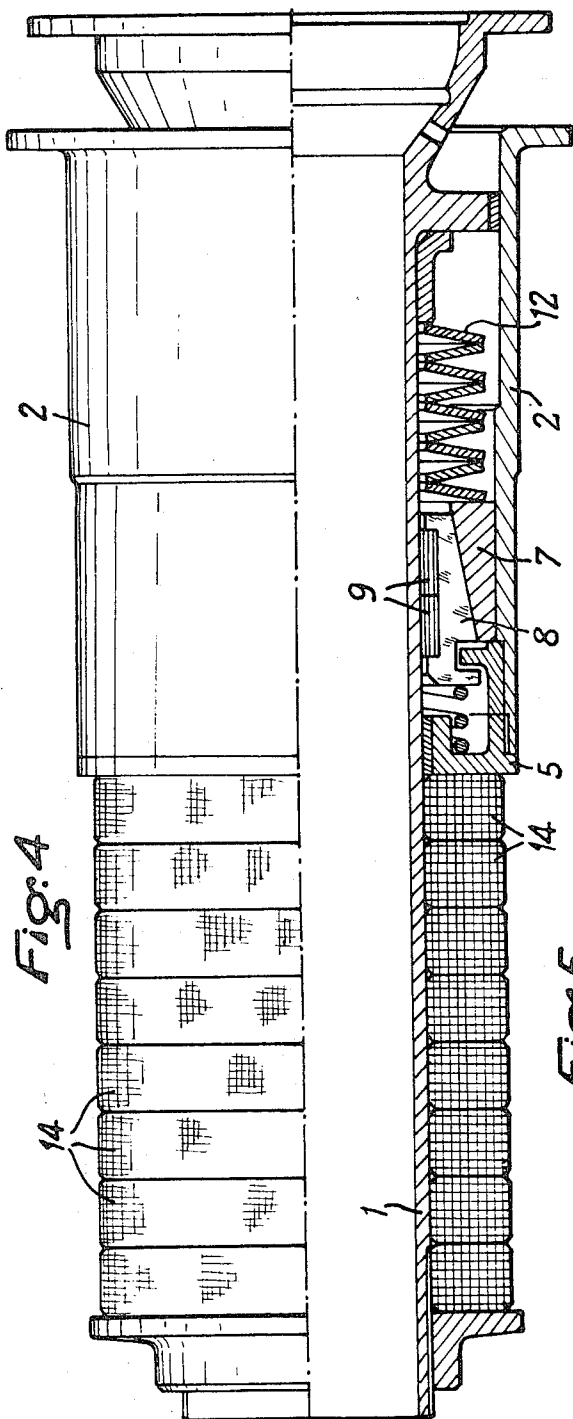
[57] ABSTRACT

Recoil absorber comprises combination of spring means and friction means for absorbing a part of the energy imparted to a weapon when it is fired. The friction means is arranged to absorb energy only during the recoil, but not when the weapon is being restored to its initial position.

21 Claims, 5 Drawing Figures







RECOIL ABSORBER

SUMMARY OF THE INVENTION

This invention relates to a recoil mechanism for connecting a member subjected to an abrupt recoil to a support and for returning the member to its initial position after the recoil. This device is particularly suitable for absorbing the recoil of repeating firearms, especially cannon mounted on airplanes.

There are already a large number of recoil absorbing devices adapted to absorb the recoil of firearms. However, when it is desired to absorb the recoil under particular conditions with respect to the distribution of the forces as a function of the displacement of the weapon it is presently necessary to utilize absorbers, especially of the hydraulic type, which are quite complex. It follows that these devices are, on the one hand, rather heavy, and, on the other hand, subject to malfunctions so that they lend themselves very poorly to the mounting of weapons such as cannon on airplanes.

The present invention proposes to provide a recoil absorber especially for repeating weapons such, for example, as cannon mounted on airplanes, which makes it possible, during the recoil, to transmit to the support a substantially constant force throughout the duration of the recoil movement. This regularity of force has the effect, on the one hand, of subjecting the support to a substantially constant pressure, and, on the other hand, of limiting to the optimum extent, the instantaneous amplitude of the pressure against this support.

It is thus possible to mount the weapon equipped with the recoil absorber according to the invention on a less strongly reinforced aircraft structure than has heretofore been the case.

It is an object of the invention to provide a recoil absorber, especially for repeating firearms, positioned between a weapon subjected to an abrupt recoil and a support, characterized by the fact that it comprises in combination at least one resilient member bearing on the one hand on said weapon and on the other hand on said support to absorb part of the energy of recoil and restore it in returning said weapon into its initial position, at least one friction means positioned between said weapon and said support and adapted to frictionally engage said weapon to dissipate part of the energy of recoil, and means for rendering said friction device inoperative during the return of the weapon to its initial position.

In accordance with a particularly advantageous characteristic of the invention, means may be provided to cooperate with the friction means in order to progressively diminish the frictional force during the recoil. This decrease in the frictional force compensates, preferably exactly, for the increase in force exerted on the support by the resilient member during the recoil.

In a preferred embodiment of the invention, the friction means comprises one or more friction surfaces held against the weapon under the influence of a wedging device adapted to urge said surface against the weapon during the recoil and to release said surface during return of the weapon to its initial position.

In a particularly advantageous form of the invention another resilient member is interposed between the movable weapon, on the one hand, and the wedging device of the friction means, on the other hand, so that during the recoil a decreasing force corresponding to the regular expansion of this resilient member is trans-

mitted to said wedging device causing a progressive release of the friction surface. During the forward movement the second resilient member again expands and presses said wedging device against the support to resist in part the force exerted by the first elastic member, which returns the weapon to its initial position with respect to the support.

In this manner, during the recoil, the progressive decrease in the frictional force transmitted to the support may compensate for the increase in the force resulting from the increase in the tension of the first resilient member, the resultant of these forces on the support then being substantially constant during the recoil.

In another embodiment of the invention an additional resilient member is inserted directly between the stationary support and the movable weapon to expand during the recoil, said friction means being positioned between the movable member and the support to transmit a constant frictional force to the support during the recoil. In this case, the two resilient members work in opposite directions during both the recoil and the return to initial position and thus exert on the support a resultant force which is increased during the recoil by the constant frictional force of the friction member.

In a variation, this additional resilient member, which may be compressed when the movable weapon is in its rest position, is decomposed well before the end of the recoil movement. This additional resilient member then serves only to absorb the terminal movement and does not have any effect on the support during the greater part of the recoil and the return to initial position.

It is also possible, in a third embodiment, to mount another resilient member directly between the support and the movable weapon, as in the preceding embodiment, while regularly decreasing the frictional force during the recoil by suitable means, for example, by imparting a very slight conicity to the member which frictionally engages the friction means, or by interposing, as in the preferred embodiment of the invention, a resilient member between the wedge of the friction member and the movable member itself.

In an advantageous arrangement, the resilient members are shaped to themselves produce a dissipation of energy during their displacement.

The wedging device may comprise, for example, a ring having a conical internal surface which narrows in the direction of recoil to form a wedge, cooperating with one or more complementary wedges in the form of sectors, for example, having an external conical convex surface and carrying on their concave inner surfaces friction members having a high coefficient of friction. When these sectors are urged in the direction of the recoil they are caused to grip and friction is produced, whereas when they are urged in the direction opposite to recoil they are separated from the movable member and no friction results.

In the first advantageous form of the invention hereinbefore described, the ring is axially slidable with respect to the support so that the decreasing force applied to said ring by said additional resilient member during the expansion of the latter during recoil causes a decrease in the gripping force exerted by the sectors against the movable member, which permits a progressive decrease in the frictional force.

In the second embodiment of the invention, in which resilient means are inserted directly between the sta-

tionary support and the movable weapon to expand during recoil, said ring may be permanently and firmly attached to the support or may be biased thereagainst by resilient means. Abutments are preferably provided on the stationary support to cooperate with corresponding surfaces on the sectors or movable wedges and transmit the force frictionally exerted against said sectors or wedges to said support.

Other advantages and characteristics of the invention will become apparent from a study of the following description, given purely by way of illustration and example, with reference to the accompanying drawings, in which:

FIG. 1 is a side view, partly in axial section, of a device according to the invention;

FIG. 2 is an axial section on a larger scale, taken through the wedging device during the recoil movement;

FIG. 3 is a similar view of the same device shown during its return to initial position;

FIG. 4 is a side view, partly in elevation, and partly in axial section, showing another device according to the invention; and

FIG. 5 is an axial sectional view on an enlarged scale showing the wedging device according to another embodiment of the invention.

Referring now to FIGS. 1, 2 and 3, a cannon, not shown, is mounted in a member to which it is fixed and which consists of a slidable sleeve 1. This sleeve is adapted to slide inside a tubular casing 2 fixed to a support consisting of the frame of the airplane on anti-friction guides 3 and 4, the first of which is supported by a ring 5 fixed to the front end of the tubular casing 2.

This ring 5 serves as an abutment for a spring 6 consisting of biconical rings adapted to frictionally absorb part of the energy of the recoil during its compression. This first spring 6 is compressed during the recoil of the sleeve 1 in the direction of the arrow F. A ring 7 is positioned in engagement with the rear edge of the ring 5 and is adapted to slide along the internal surface of the tubular casing 2. The internal surface of this ring 7 is conical to form a wedging surface, encircling an imaginary conical surface which narrows from front to back, that is to say in the direction of the arrow F. In this ring 7 are several conical sectors 8 which are freely mounted, said conical sectors 8 (one of which is shown on FIG. 1) carry on their inner surfaces linings 9 made of a material having a high coefficient of friction and highly resistant to wear. These linings, which are positioned against the outer surface of the sleeve 1 constitute the frictional member. By way of example, the conicity of the ring 7 (and the sectors 8) may be of the order of 8 degrees, and the coefficient of friction (as a dynamic function) of the linings may be of the order of 0.3. The axial path of travel of the wedge 8 in both directions is limited by a flange 10 on the ring 5 inserted in a corresponding but much longer neck in the conical sectors 8. The spacing between the ends of the neck and the flange may be, for example, of the order of 1 mm for a cannon mounted on an airplane, with a recoil of 20 to 30 mm. A small, weak, spring 11 bearing on the bottom of the ring 5 constantly biases the wedge 8 in the direction of recoil.

Another spring 12 formed, for example, of Belleville washers, bears against the rear surface of the conical ring 7 and against an abutment 13 fixed to the sleeve

1. When the cannon is in firing position, as shown in FIG. 1, the first spring 6 is expanded whereas the other spring 12 is compressed and exerts pressure against the ring 7. The operation is as follows:

During the recoil from the position illustrated in FIG. 1, the member 1 moves in the direction of the arrow F, compressing the spring 6, and dissipating, due to this compression, part of the energy. At the beginning of the recoil movement the conical sectors 8, which are constantly biased in the direction of the arrow F by the spring 11, are driven in the direction of the arrow by the sleeve as it recoils, and urges the ring 7 in the same direction, because the frictional force is selected to be greater than the resistance of the spring 12 in the compressed state. After a short movement, sectors 8 abut against the flange 10 as illustrated on FIG. 2, and from this moment the friction between the sleeve 1 and the members 8 dissipates a substantial part of the energy.

During this movement, which causes friction between the sleeve 1 and the linings 9, the second spring 12 progressively expands while also dissipating energy during its expansion. It follows that to the extent to which the spring 12 expands, the force exerted by this spring against the ring 7 decreases and consequently, the frictional force between the linings 9 and the sleeve 1 which is dependent on the wedging effects progressively decreases.

Consequently, the forces exerted in the direction of the arrow F on the tubular casing 2 through the ring 5 are determined, from the moment very close to the beginning of the recoil at which the sectors 8 abut the flange 10 as shown in FIG. 2, by the increasing compressive force exerted by the spring 6, plus the decreasing frictional force always exerted in the direction of the arrow F on the flange 10, which force constantly decreases because of the progressive expansion of the spring 12 and the consequent weakening of the frictional force. Thus, by suitably selecting the characteristics of the springs 6 and 12, the frictional linings, and the conical surfaces effecting the wedging action, it is possible to very accurately compensate for the increase in force on the support resulting from the contraction of the spring by a decrease in the frictional force, so that the total force applied to the tubular casing 2 remains substantially constant throughout almost the entire recoil movement.

At the end of the recoil, the spring 6, which has been compressed, returns the sleeve 1 forwardly in a direction opposite to that indicated by the arrow F. From the beginning of this movement, the frictional force exerted by the linings 9, if it still remains, is eliminated, since they are moved in an unwedging direction. Under these conditions, the spring 12 while being relatively decompressed, is still sufficiently compressed to drive the ring 7 and the sectors 8 in a direction opposite to the arrow F so that the ring 7 is brought very rapidly into abutment against the back of the stationary ring 5. From this moment, the frictional force is completely eliminated, and the spring 12 exerts, through the ring 7, a steadily increasing force in a direction opposite to the one indicated by the arrow F on the ring 5 attached to the support, which force partially resists the steadily decreasing force exerted on said ring 5 in the direction of the arrow F by the spring 6 as it decompresses. The spring 12 thus serves to cushion the return movement of the sleeve 1.

Referring now to FIG. 4, this embodiment of the invention is distinguished from the embodiment illustrated in FIG. 1 by the fact that the spring 6 having bi-conical rings is replaced by a stack of cushions of knitted steel thread which have the advantage that, during their resilient compression, they absorb a substantial quantity of energy, thus making it possible to limit the amplitude of the recoil and the friction. Of course, the second spring 12 may also be replaced by a stack of annular cushions of knitted steel thread.

Referring now to FIG. 5, this embodiment of the device according to the invention has a spring 15, consisting for example of cushions of knitted steel thread, which is compressed, in the rest position of the cannon, between a shoulder 16 on the slidable member 1 and an abutment 17 on the stationary cylindrical casing 2. The wedge formed by the conical ring 7 is biased in a direction opposed to that of the arrow F by a resilient member 18 consisting simply of two Belleville washers, the last of which bears against the front face of the stationary abutment member 17.

In this embodiment, the operation is as follows:

The beginning of the recoil of the sleeve 1 in the direction of the arrow F results in the relative displacement of the members 7 and 8 and the compression of the resilient member 18 until the front abutment of the sectors 8 comes into contact with the shoulder 10 as illustrated in FIG. 2. From this moment, the friction between linings 9 and the outer surface of the sleeve 1 begins, and the frictional driving force in the direction of the arrow F is transmitted, especially by the sectors 8, to the flange 10 of the ring 5. During the entire recoil movement the frictional force remains constant, its magnitude being determined by the force applied by the resilient member which bears against the stationary member 17, against the lower wedge 7. To the increasing force exerted in the direction of the arrow F on the structure by the spring such as 14 there is thus added the constant driving force frictionally exerted by the sectors 8 on the supporting structure. On the contrary, the second spring 15, which is initially compressed, tends to expand, so that the force applied by this spring against the stationary member 17 in the direction opposite to the arrow F, steadily decreases.

During the return to initial position, which takes place in a direction opposite to that of the arrow F, the wedging effect is eliminated and the frictional force is thus practically eliminated. The only forces still effective are the antagonistic forces exerted on the support by the springs 14 and 15.

The spring 15 may also be adapted to completely expand after an initial fraction of the recoil movement so that during the remainder of the recoil movement (and the corresponding part of the return movement) it has no effect on the stationary support.

At the end of the return movement the sliding sleeve 1 abuts against the spring 15 and is cushioned as it compresses.

It is possible, on the other hand, to eliminate the resilient support 18 and directly attach the cylindrical casing 2 to the conical sector 7. In this case the flange 10 may be eliminated as well as the corresponding front abutment of the sectors 8 which then transmit their frictional force directly through the ring 7.

While the invention has been described in certain particular forms, it will be appreciated that the scope of the invention is not limited to the details thereof,

which may be modified as to shape and material without thereby departing from the basic principles of the invention. Moreover, it is obvious that, while the present description illustrates the application of the device to a cannon mounted on an airplane, the recoil absorber according to the invention may be applied in many other environments to absorb the recoil of weapons, or of any other device.

What is claimed is:

1. A recoil absorbing device mounted between a movable member subjected to an abrupt recoil and a support, said device comprising:

a resilient member bearing against both said member and said support to store part of the energy imparted to said member during recoil and return it by returning said member to its original position after said recoil;

a friction-producing device positioned between said member and said support and frictionally engaging said member in relative sliding relation during at least a part of said recoil to dissipate part of the energy imparted to said member during recoil, said friction-producing device bearing against said support during said at least a part of a recoil,

friction control means responsive to said recoil to reduce progressively the amount of friction produced during said recoil,

said friction-producing device comprising means for removing friction during return of said member to its original position.

2. A device as claimed in claim 1 in which said friction-producing device comprises at least one wedge-shaped friction member, frictionally engaging said movable member and at least one complementary wedge, said friction control means comprising means for urging said complementary wedge against said wedge-shaped friction member.

3. Device as claimed in claim 2 in which the movable member comprises a sleeve slidable in said support and said friction-producing device comprises a ring having a conical inner surface cooperating with external conical surfaces of a plurality of sectors, said sectors being provided with friction linings in contact with said movable member.

4. Device as claimed in claim 4 which comprises an additional resilient member positioned between said ring and movable member, which additional resilient member expands during recoil to permit sliding of said ring to progressively decrease the frictional force produced, and means for transmitting to said support the frictional force applied to said sectors.

5. Device as claimed in claim 5 in which said additional resilient member consists of Belleville washers.

6. Device as claimed in claim 4 in which said sectors have necks permitting displacement of said sectors on opposite sides of a shoulder of an abutment attached to said support, and said sectors are constantly biased in the recoil direction toward said conical ring by a relatively weak resilient member bearing against said support.

7. Device as claimed in claim 1 which comprises an absorbent cushion made of woven wire bearing against said support and against which said movable member is cushioned at the end of its return to its initial position.

8. Device as claimed in claim 15 in which said resilient member which returns the movable member to its

initial position comprises a plurality of biconical cooperating washers.

9. Device as claimed in claim 15 in which the resilient member which returns the movable member to its initial position consists of a stack of resilient members made of woven metallic fibers.

10. Device as claimed in claim 15 in which the movable member is an aeronautical cannon.

11. A recoil absorbing device mounted between a movable member subjected to an abrupt recoil and a support, said device comprising,

a resilient member bearing against both said member and said support to store part of the energy imparted to said member during recoil and return it by returning said member to its original position after said recoil,

a friction-producing device positioned between said member and said support and frictionally engaging said member in relative sliding relation during at least a part of said recoil to dissipate part of the energy imparted to said member during recoil, and bearing against said support during said at least a part of said recoil,

a friction control means to keep constant the amount of friction produced during the recoil, said friction-producing device comprising means for removing friction during return of said member to its original position.

12. A device as claimed in claim 11 in which said friction-producing device comprising at least one wedge-shaped friction member cooperating with at least one complementary wedge.

13. A device as claimed in claim 12 wherein said at least one complementary wedge is secured to said support for keeping said friction amount constant.

14. A device as claimed in claim 12 in which said movable member comprises a sleeve slidable in said support and said friction-producing device comprises a ring having a conical inner surface cooperating with external conical surfaces of a plurality of sectors, said sectors being provided with friction linings in contact with said movable member.

15. A device as claimed in claim 14 which comprises an additional resilient member positioned between said ring and said support, and in which said sectors have necks permitting displacement of said sectors on opposite sides of a shoulder of an abutment attached to said

support, and wherein said sectors are constantly biased in the recoil direction toward said conical ring by a relatively weak resilient member bearing against said support.

16. A device as claimed in claim 11 which comprises an absorbent cushion of woven wire bearing against said support and against which said movable member is cushioned at the end of its return to its initial position.

17. A device as claimed in claim 11 in which said resilient member which returns said movable member to its initial position comprises a plurality of biconical cooperating washers.

18. A device as claimed in claim 11 in which said resilient member which returns said movable members to its initial position consists of a stack of resilient members made of woven metallic fibers.

19. A device as claimed in claim 11 in which said movable member is an aeronautical cannon.

20. A recoil absorbing device mounted between a movable member subjected to an abrupt recoil and a support, said device comprising,

a resilient member bearing against both said member and said support to store part of the energy imparted to said member during recoil and return it by returning said member to its original position after said recoil,

a friction-producing device positioned between said member and said support comprising at least one wedge-shaped friction member provided with a neck means and a complementary wedge member, said wedge-shaped friction member being movable between a recoiled operative position wherein said neck means engage a shoulder means for transmitting friction forces, and an advanced inoperative position wherein said neck means are disengaged from said shoulder means, and a friction control means urging said complementary wedge member against said wedge-shaped member with a pressure which avoids any increase in the amount of friction produced during the recoil.

21. A recoil absorbing device as claimed in claim 21 wherein said friction control means comprise a relatively weak resilient member engaging said wedge means.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,783,738 Dated 8 January 1974

Inventor(s) PATRICE PELAT

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[30] Foreign Application Priority Data

March 1, 1971 France.....7106918

Signed and sealed this 4th day of June 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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