

K. VÖLLER.
 RECOIL BRAKE FOR ORDNANCE.
 APPLICATION FILED OCT. 19, 1905.

1,004,116.

Patented Sept. 26, 1911.

4 SHEETS—SHEET 1.

Fig. 1.

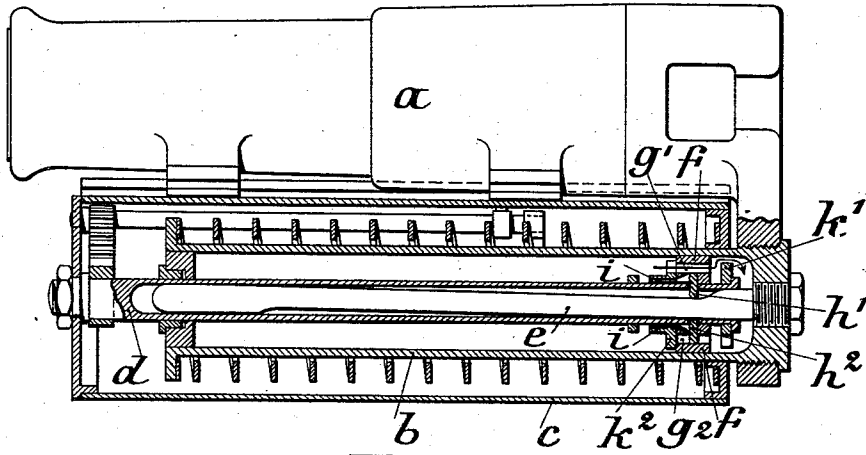
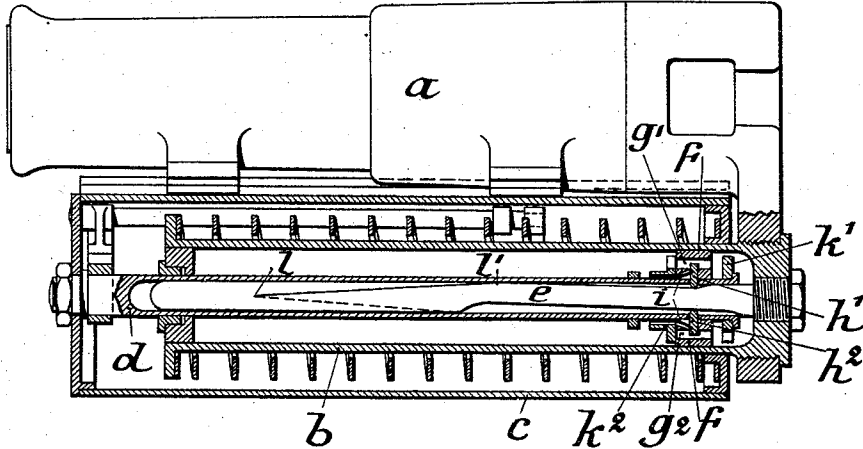


Fig. 3.



WITNESSES

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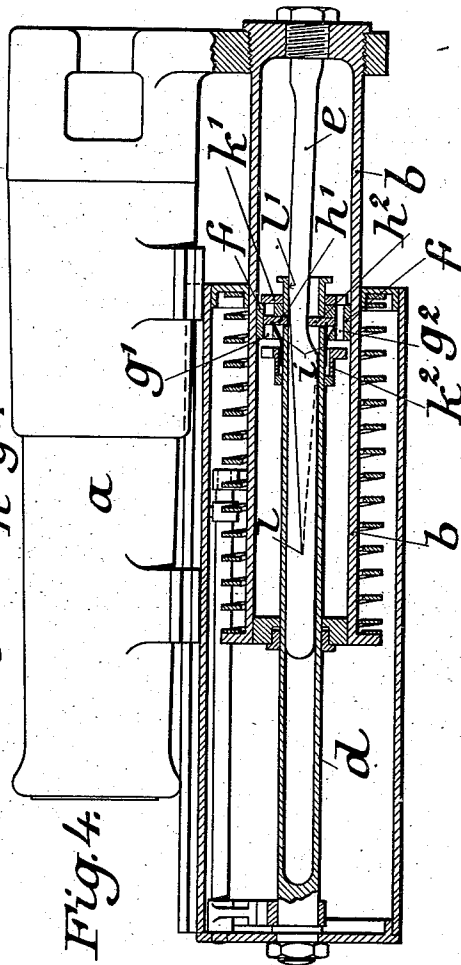
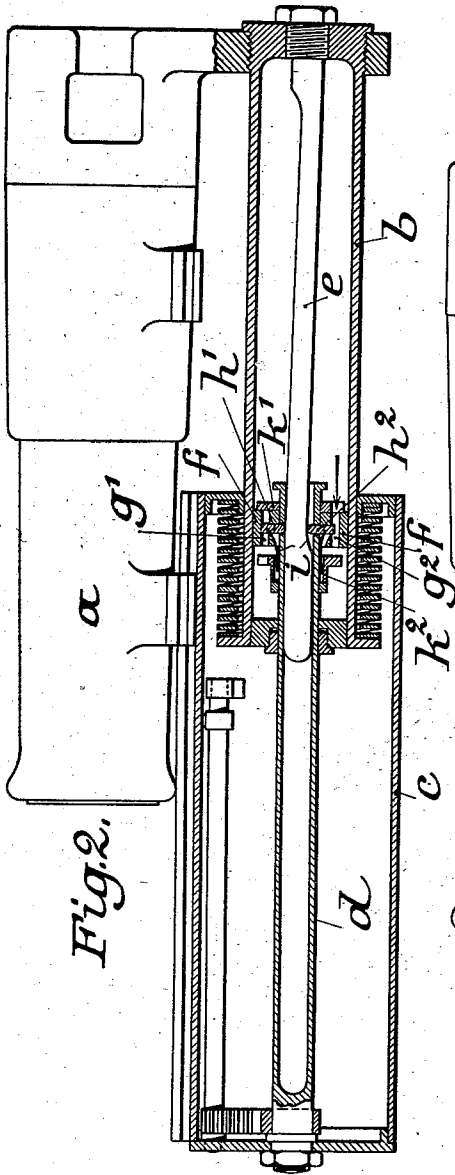
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4 SHEETS—SHEET 2.

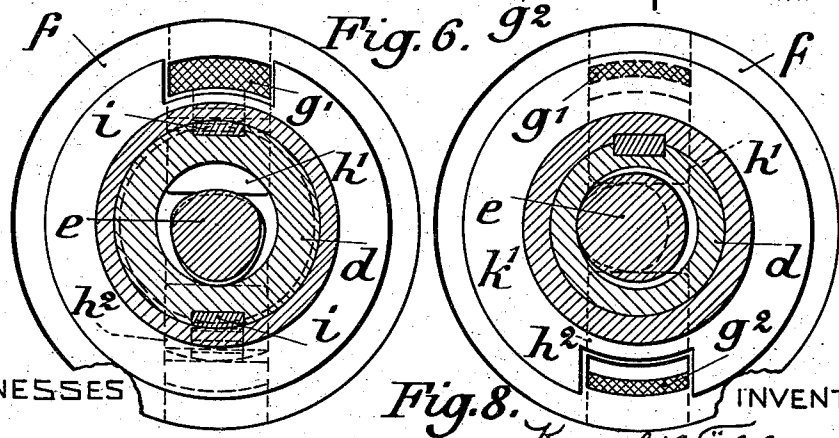
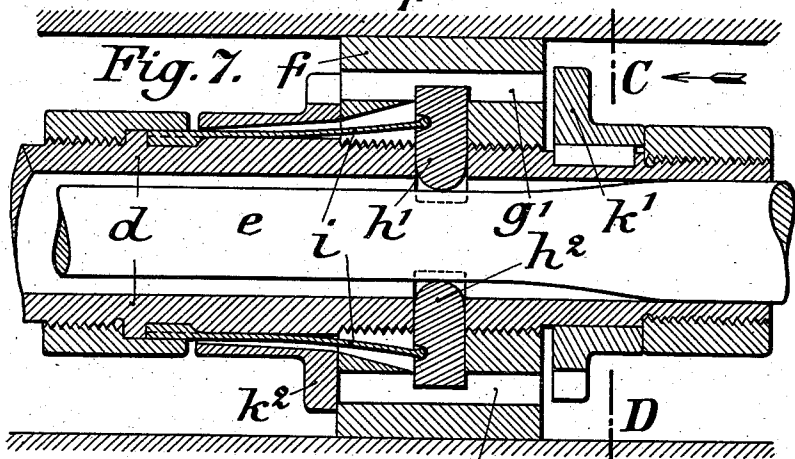
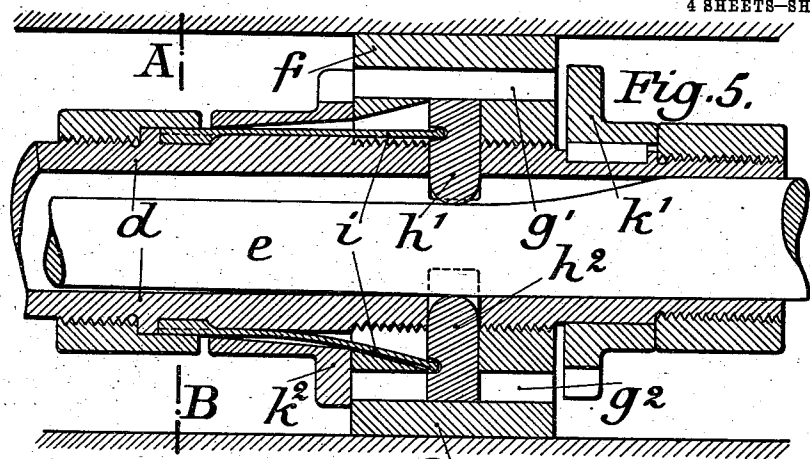


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Fig. 8.

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4 SHEETS—SHEET 4.

Fig. 9.

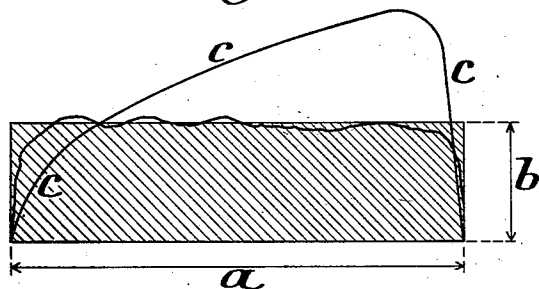
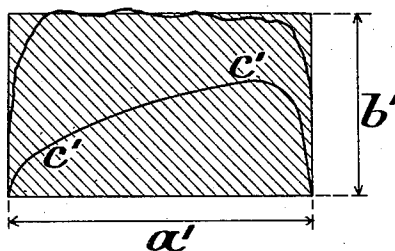


Fig. 10.



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UNITED STATES PATENT OFFICE.

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RECOIL-BRAKE FOR ORDNANCE.

1,004,116.

Specification of Letters Patent.

Patented Sept. 26, 1911.

Application filed October 19, 1905. Serial No. 283,406.

To all whom it may concern:

Be it known that I, KARL VÖLLER, engineer, a subject of the German Emperor, residing at 47 Fülcherstrasse, Dusseldorf, Germany, have invented certain new and useful Improvements in Recoil-Brakes for Ordnance; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to a recoil brake for ordnance in which the gun recoils upon the carriage, and it has for its object a construction by means of which the brake pressure or fluid pressure existing in the brake cylinder during the recoil and during the running forward, can be accurately varied according to definite laws corresponding to the theoretical or practical requirements, such for example, as is necessary on the elevation of the gun being altered.

My invention consists for this purpose, in that for varying the inlet or outlet openings for the brake liquid, radially movable slides are arranged in a piston body fixed on the piston rod which, on the movement of the brake cylinder, slide along a curved guide.

A construction for carrying out the said invention is shown on the accompanying drawings.

Figure 1 shows a side view of the gun with a longitudinal section of the brake apparatus at the moment of the commencement of the recoil of the gun when this is in a horizontal position; Fig. 2 shows the same view of the said parts at the end of the recoil of the gun in the horizontal position; Figs. 3 and 4 show in the same way the beginning and end of the recoil with the gun in an inclined position; Fig. 5 shows upon an enlarged scale, a longitudinal section through the brake piston and the contiguous parts in the position corresponding to Fig. 1, Fig. 6 is a cross section on line A—B of Fig. 5; Fig. 7 shows the same parts as Fig. 5 when in the position shown at Fig. 3, Fig. 8 shows a cross section on line C—D at Fig. 7. Figs. 9 and 10 are diagrams illustrative of the principles involved in one feature of my invention.

As shown at Fig. 1 there is combined with the gun *a* in the usual manner the brake cylinder *b*, which is built into the upper gun

carriage *c*. To the front plate of the upper gun carriage is fixed a piston rod *d* which in this case is hollow and which, on varying the elevation of the gun and upper carriages receives a rotation by any suitable mechanism, such, for example, as that shown in the United States patent granted to me March 22, 1904, No. 755,418. Within the hollow piston rod engages a rod *e* which is fixed to the end wall of the brake cylinder that is secured to the gun as shown and which I will call a guide-bar. This guide-bar therefore moves backward and forward with the gun, it is formed cylindrical only at its front end which serves to guide it in the hollow of the piston rod. The other part of the guide-bar has a longitudinally profiled shape.

On the free end of the piston rod *d* is mounted the brake piston which is of peculiar construction shown at Figs. 5 to 8. The piston consists of a middle disk *f* which is guided in the brake cylinder and is in contact with the entire periphery thereof; it is formed with axial channels *g'* and *g''* for the passage of fluid, with which communicate radial slots in which are radially movable slides *h'* and *h''*. According as these slides project more or less or not at all into the channels *g'* and *g''*, they either restrict or entirely close the channels against the flow of the braking fluid, or they leave them entirely open. The slides *h'* and *h''* extend through the sides of the piston rod and bear with their inward directed ends against the side of the guide bar *e* which is presented to them. In the example shown they are held by springs *i* continuously in contact with the guide bar. With this construction the slide *h'* controls the recoil and the slide *h''* the forward run.

In front and behind the piston disk *f* there are mounted upon the piston rod valve disks *k'* and *k''* that can slide longitudinally but cannot turn thereon and that are so formed that on bearing against *f* the disk *k'* covers the upper channel *g'* and the disk *k''* the lower channel *g''*.

I will first consider the recoil of the gun in the horizontal position. The longitudinal profile of the guide bar *e* is in this case formed by the upper boundary line shown at Fig. 1 from which it will be seen that at the rear end of the piston rod the profile line

is nearest to the axis of the piston rod and gradually rises in the forward direction, until, at a distance that corresponds to the recoil of the gun in the horizontal position, it terminates in the cylindrical surface of the front part of the guide bar. If now, during the recoil, the guide bar moves backward, at which time it will be noted that the piston rod together with the piston remained stationary, the upper profile of the guide bar will press the slide h' out of the position shown in Figs. 1 and 5 upward into the channel g' , so that during the recoil this channel will be gradually restricted as shown at Fig. 7 and at the end of the recoil (Fig. 2) it will be entirely closed. At the commencement of the recoil also the disk h^2 will be forced, by the pressure of the fluid, against the disk f , while the disk h' will be forced backward away therefrom as shown at Fig. 5. The lower channel g^2 is consequently closed during the recoil and the braking fluid only passes through the channel g' which is gradually restricted and closed during the recoil as above described.

At the forward run on the other hand, the commencement of which is shown at Fig. 2, the disk h' will bear against the piston f thereby closing the channel g' , while disk h^2 is pushed away, thereby opening channel g^2 . If now the slide h^2 were not provided, then during the entire forward run the cross sectional area for the flow of braking fluid would remain the same. The guide bar e , however, has also on its underside a cam surface of such form that also during the forward run, the slide h^2 is made to gradually restrict and eventually to close the channel g^2 . The longitudinal profile or cam surface of the guide bar is, however, not restricted to the upper and lower side in the horizontal position of the gun, but passes around its periphery. It is, however, not the same at all parts but is varied in such manner that the cam surface, in the horizontal position of the gun, reaches up to the cylindrical part of the guide bar and is as long as the longest recoil; is reduced in a plane shifted say 45° from the above position to about the half of the longest recoil and reaches up to the cylindrical surface of the guide bar at the middle point between the commencement and end of the above mentioned cam surfaces. In Figs. 3 and 4 this alteration of the longitudinal profile is shown, it being assumed that the guide bar has been turned through a certain angle relative to the piston. In reality, the guide bar retains its position, while the piston rod with the piston is turned on altering the elevation in the known manner. In the longitudinal sectional planes lying between the two abovementioned limits, the length of the cam surfaces of the guide bar continually decreases. The end points therefore lie

upon a helical line which connects the two limits l and l' together. Otherwise, the recoil cam surface has, at every sectional plane, the same inclination to the central axis of the piston rod (Figs. 1 to 4), so that at every cross section of the guide bar the cam surfaces are at a different distance from the central axis of the piston rod, and as a consequence the cross section presents an eccentric form as seen at Figs. 6 and 8. In consequence of the rotation of the piston rod, the slides h' and h^2 come in contact with different cam surfaces of the guide bar. Figs. 3 and 4 show the position of the parts for the greatest angle of elevation. Fig. 3 shows the commencement of the recoil. In consequence of the rotation of the piston rod, the slide h' will have arrived upon a shallower portion of the cam surface and is thereby made to close the channel g' to the extent of about one half, at the commencement of the recoil as shown in Fig. 7. The cam surface of the guide bar terminates in the operating position thereof in the middle of l' (Figs. 3 and 4), and the channel g' is therefore closed at one half of the longest recoil as shown in Fig. 4, so that the gun is brought to a standstill. By the rotation of the piston rod the conditions have also been altered in respect of the forward run, namely they are the reverse of the conditions for the recoil. While in the horizontal position of the gun at the commencement of the forward run Fig. 2, the channel g^2 is about half closed, on the increase of the elevation it will be opened to a greater extent and at the greatest elevation, it will be entirely opened as at Fig. 4. The cam surfaces of the guide bar for the forward run are therefore formed in the opposite manner to those for the recoil.

With the described construction, the cam surfaces for the radial shifting of the slides, for the forward run and recoil, can be varied according to circumstances. While in the described example it is assumed that the slides, in following the surfaces of the guide bar, are, during the recoil, progressively removed from the center line of the piston rod and during the forward run progressively approach the same, if circumstances should make it desirable, the continuity could be interrupted or varied at certain points. For example, by means of the described construction the action might be made such that the channels for the flow of braking fluid are increased instead of decreased during the recoil on elevating the gun. Such a construction of the guide bar might, for example, be desirable if, in the case of field guns, a shortening or extension of the recoil, on varying the elevation of the gun, be not desired but on the other hand it be desired that the fluid pressure within the brake cylinder, shall remain as nearly as

possible the same at all angular positions of the gun and shall not increase when the gun is elevated.

In the described arrangement the inner surface of the brake cylinder is perfectly smooth and does not contain any grooves or projecting ribs which, in consequence of wear, may easily lose their proper configuration and which are of very difficult construction on the inner surface of the cylinders, while on the other hand, the formation of the cam surfaces on the outer surface of the guide bar is very simple. The cam surface can, during its construction and afterward, be accurately gaged by means of templates and, if necessary, corrected. The slides are also of very simple construction and can be easily replaced by new ones when they or the cam surfaces become worn.

In the described construction the regulating slides are kept, by means of springs, against the guide bar; but they may, however, be so arranged as to receive a prescribed motion thereon if there be provided on the guide bar other cam surfaces parallel and therefore in the opposite direction to the working cam surfaces, the slides being so formed as to embrace both such cam surfaces, in which case the slides for the forward run and the recoil, can be arranged in different planes.

In Figs. 9 and 10, I have illustrated diagrammatically an underlying feature of the preferred form of my invention. As will be fully understood by those skilled in the art, the function of the recoil device is to oppose a resistance to the recoil of the gun, whereby the energy of recoil is expended in work in overcoming the said resistance. The most favorable method of applying this resistance, as is well known, is to maintain a substantially uniform resistance pressure throughout the recoil, whereby the amount of the resistance pressure which is to be applied to overcome the recoil of the gun will be a continually acting mean pressure instead of fluctuating between a maximum and a minimum. Under the latter conditions, viz.—when the pressure fluctuates between a maximum and a minimum, the parts must all be constructed to withstand the maximum pressure, thereby rendering them heavier, and in addition, the recoil is not steady and a severe straining of the carriage takes place. In Fig. 9, which represents the action which takes place at zero elevation of the gun, that is to say, when the gun is level, the amount of work which must be done by the resistance of the recoil device is indicated by the area of the rectangle, having the length a equal to the length of recoil at zero elevation, and the height b which represents the value of the resistance pressure. In practice, probably owing to slight variations in the frictional resistance at dif-

ferent parts of the recoil, it is not always possible to attain the ideal condition of an absolutely uniform pressure throughout the recoil, but the curve of pressure usually occurring in practice will vary slightly from the true rectangle. This is indicated by the heavy irregular line shown in Fig. 9. This resistance pressure consists, aside from frictional resistance of the moving parts, of spring pressure and the fluid pressure in the recoil cylinder. Theoretically, the spring pressure would be represented diagrammatically by a right angle triangle or (where the spring has an initial pressure even in its most extended position, namely, when the gun is in its position for firing) by a geometrical figure formed by a right angle triangle whose base rests upon a rectangle. This is on the assumption that a spring can be made in which the tension will increase in direct proportion to the decrease in length. Since in practice, springs can rarely be made which will fully meet this theoretical condition, the diagram representing the real spring pressure varies somewhat from the ideal diagram. In order that the diagram of resistance pressure may be substantially a rectangle, the fluid pressure, in the recoil cylinder should give a diagram in which the ordinates of the curve representing the fluid pressure are equal to the difference between the corresponding ordinates of the rectangle and the spring pressure, that is to say, the value of the spring pressure at any instant, plus the value of the fluid pressure at the same instant should always be equal to the sum of the corresponding values at any other instant throughout the recoil, at any particular angle of elevation. Theoretically, the diagram of the fluid pressure would be a triangle but in practice it deviates from this ideal. The fluid pressure at any instant depends upon the velocity of discharge of the fluid in the brake-cylinder through the throttling opening or openings. As this velocity of discharge depends upon the velocity of recoil at the same instant (which velocity varies at different instants) as well as upon the area of the discharge or throttling opening at the same instant, and upon some modifying causes such as the viscosity of the braking fluid, the vortex action and the frictional resistance of the liquid in passing through said opening, and as the latter vary with variations of velocity of recoil, the curve which represents the area of the discharge opening during the recoil at any given angle of elevation, is not a simple curve and does not necessarily follow the same law as the curve which represents the area of the throttling opening at some other angle of elevation. In Fig. 9, c is supposed to indicate the curve whose ordinates represent the areas of the throttling opening at the respective stages of

the recoil. In this diagram, it is assumed that if the variation in the area of the throttling opening follows the law represented by said curve *c*, the resistance pressure of the recoil device will be substantially uniform throughout the recoil at the horizontal position of the gun. It has been found possible in practice heretofore to construct throttling devices so that the area of discharge would vary during the recoil at a certain angle of elevation so as to give a substantially uniform resistance pressure throughout the recoil at the particular angle, but in such prior construction, a change in the angle of elevation would introduce other conditions such as, for example, a change in the action of gravity on the gun, and a demand for a variation in the length of the recoil, whereby the resistance pressure would not remain substantially uniform throughout the recoil at such other angle of elevation, for the reason, that in such prior constructions, the area of the throttling opening was diminished in passing from one angle of elevation to another by a certain amount which amount of diminution of area was fixed throughout the recoil at that particular angle of elevation. By my invention, the resistance pressure of the recoil device is maintained substantially uniform throughout each recoil of the gun, although the value of such uniform resistance pressure at one angle of elevation may be different from the value of the substantially uniform resistance pressure at some other angle of elevation. In the preferred form of construction, the value of the uniform resistance pressure increases with an increase of the angle of elevation, though not necessarily in direct proportion to the angle of elevation. Fig. 10 of the drawing illustrates the diagram supposed to be obtained at some positive angle of elevation wherein the recoil is shortened. Under these conditions, the shaded rectangle *a'*, *b'* represents the ideal curve of resistance pressure, the full line, the curve which might be actually obtained in practice and *c'* the curve whose ordinates indicate the area of the throttling opening or openings at the particular instant considered. In the embodiment of the invention shown in the drawings, I attain the above results by providing a structure in which practically each angle of elevation is given its own controlling device for controlling the throttling of the fluid, although all these different controlling devices are merged into one body, viz.—the guide bar *e*. A different longitudinal portion of the surface of this guide bar *e* is brought into action for each different angle of elevation, and each longitudinal portion can be given the profile which is demanded by the conditions to be met at that particular angle of elevation in order to obtain the proper length of recoil and the

proper value of the uniform pressure necessary to act on the gun to stop it at that length of recoil. Moreover, as hereinbefore explained, the same guide-bar also provides for a proper control of the throttling action during the counter recoil and at each angle of elevation.

Having thus fully described my invention, what I claim is:

1. A recoil brake for ordnance embodying a recoil element having an independently operating recoil-controlling means for each angle of elevation of the gun, said controlling means starting from a different point for each of such angles of elevation, whereby any desired predetermined control of the recoil at any angle of elevation may be obtained.

2. A recoil brake for ordnance embodying an automatically adjusted recoil element having an independently-operating recoil-controlling means for each angle of elevation of the gun, said controlling means starting from a different point for each of such angles of elevation, whereby any desired predetermined control of the recoil at any angle of elevation may be obtained.

3. A recoil brake for ordnance embodying a rotary recoil element having independently operating recoil controlling means for each angle of elevation of the gun.

4. A recoil brake for ordnance, embodying a recoil controlling element having an individual guiding surface for each angle of elevation of the gun, and a fluid controlling means guided by said surfaces.

5. A recoil brake for ordnance embodying a rotary recoil controlling element having separate operating means for each angle of elevation of the gun, and a fluid controlling member co-acting with the element.

6. A recoil brake for ordnance embodying a recoil controlling element having operating surfaces for each angle of elevation of the gun, and throttling members co-acting with the element.

7. A recoil brake for ordnance embodying a rotary recoil controlling element having operating surfaces for each angle of elevation of the gun, and throttling members co-acting with the element.

8. A recoil brake for ordnance embodying a recoil controlling element having operating surfaces for each angle of elevation of the gun, and shiftable slides co-acting with the element.

9. A recoil brake for ordnance embodying a rotary recoil controlling element having operating surfaces for each angle of elevation of the gun, and shiftable slides co-acting with the element.

10. The combination with a gun, a recoil device arranged to check the recoil of said gun, and controlling means for controlling said recoil device, of mechanism having a

plurality of independently-operating surfaces, one for each angle of elevation of the gun, said mechanism being arranged to control the recoil-controlling means.

11. The combination with a gun, of a recoil device, cam surfaces for controlling said recoil device during the recoil of the gun, and separate cam surfaces for controlling said recoil device during counter-recoil.

12. The combination with a gun, of means for maintaining, at all angles of elevation, a resistance pressure to recoil that is substantially uniform throughout each recoil.

13. The combination with a gun, of means for maintaining, at all angles of elevation, a resistance pressure to recoil that is substantially uniform throughout each recoil, the value of such resistance pressure changing with a change in the elevation of the gun.

14. The combination with a gun, of means for maintaining at all angles of elevation, a resistance pressure to recoil that is substantially uniform throughout each recoil, the value of such resistance pressure increasing with an increased elevation of the gun.

15. The combination, with a gun and a recoil device, of means for maintaining, at all angles of elevation, a resistance pressure of the recoil device substantially uniform throughout each recoil.

16. The combination, with a gun and a recoil device, of means for maintaining, at all angles of elevation, a resistance pressure of the recoil device substantially uniform throughout each recoil, the value of such resistance pressure changing with a change in elevation of the gun.

17. The combination, with a gun and recoil device, of means for maintaining at all angles of elevation, a resistance pressure of the recoil device substantially uniform throughout each recoil, the value of such resistance pressure increasing with an increase in elevation of the gun.

18. In a recoil brake for guns of the kind herein referred to, the combination with the piston of the brake cylinder, having channels for the passage of the braking fluid, of radially movable slides adapted to vary the sectional area of said channels during the recoil and forward run, which slides during the motion of the brake cylinder, slide against cam surfaces on a guide bar fixed to the brake cylinder, substantially as described.

19. In a recoil brake for guns of the kind herein referred to, the combination with the piston of the brake cylinder, having channels for the passage of the braking fluid, of radially movable slides adapted to vary the sectional area of said channels during the recoil and forward run, which slides during the motion of the brake cylinder, slide against cam surfaces on a guide bar fixed to the brake cylinder, said guide bar having

on its periphery variously formed cam surfaces, so that on the rotation of the piston and piston rod, the radial slides are thereby shifted relatively to the said channels so as to vary the sectional area thereof and thereby to produce the minimum sectional area at an extent of recoil which is the shorter the greater is the elevation of the gun and the consequent extent of rotation of the piston rod.

20. In a recoil brake for guns of the kind herein referred to, the combination with the piston of the brake cylinder, having channels for the passage of the braking fluid, of radially movable slides adapted to vary the sectional area of said channels during the recoil and forward run, which slides during the motion of the brake cylinder, slide against cam surfaces on a guide bar fixed to the brake cylinder, the sectional area of the piston channels that are closed during the recoil and are open during the forward run, being varied by the radial slides in sliding against the cam surface of the guide bar, while the channels for the recoil remain closed substantially as described.

21. In a recoil brake for guns of the kind herein referred to, the combination with the piston of the brake cylinder having channels for the passage of the braking fluid, of radially movable slides adapted to vary the sectional area of said channels during the recoil and forward run, which slides during the motion of the brake cylinder, slide against cam surfaces on a guide bar fixed to the brake cylinder, said guide bar being provided on a portion of its periphery with different cam surfaces for the forward run so that during the rotation of the piston rod, the slides controlling the forward run, receive a different position relatively to the sectional area of the said channels and thereby vary these so that the greater the elevation and the resulting angle of rotation the greater the sectional area becomes during the forward run.

22. In a fluid brake for guns, a fluid brake cylinder, a recoil device therein comprising two members relatively movable in two directions at right angles to each, said recoil device being arranged to be controlled during recoil by one of said relative movements and to be set to meet the requirements of different gun elevations by the other of said relative movements, and means actuated by the movement of the gun in elevation and arranged to produce said setting movement of the two members.

23. In a fluid brake for guns, the combination, with a gun arranged to be adjusted in elevation, a fluid brake cylinder, and a recoil device therein comprising two members arranged for relative axial and angular movements, said recoil device being arranged to be set by one of said relative

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movements and to be controlled during recoil by the other of said relative movements, of means actuated by the movement of the gun in elevation and arranged to cause that
 5 relative movement of said members which sets the recoil device.

24. The combination, with a carriage, and a gun arranged to be adjusted in elevation and to recoil relative to said carriage, of a
 10 cylinder, a recoil device within the cylinder and comprising two members arranged for axial and angular movements relative to each other, said recoil device being arranged to be set by one of said movements
 15 and to be controlled during recoil by the other of said movements, and means whereby the adjustment of the gun in elevation will produce one relative movement of said members to set the recoil device and the
 20 recoil of the gun will produce the other relative movement to control the recoil.

25. In a fluid brake for guns, the combination, with a brake cylinder and a piston provided with ports for the braking fluid,
 25 of a valve-mechanism operating member, said member and the piston having axial and angular movements relative to each other, a valve mechanism for controlling said ports, said valve mechanism being arranged to be set before firing by one of
 30 said relative movements and to be actuated during recoil by the other of said relative movements, and means actuated by the movement of the gun in elevation and arranged to cause that relative movement of
 35 said member which sets the valve mechanism.

26. In a fluid brake for guns, the combination, with a brake cylinder, and a piston
 40 provided with ports for the braking fluid, of a valve mechanism arranged to control said ports, and a member for operating said valve-mechanism, said member and the piston having two movements relative to each other, one of said movements
 45 being at right angles to the other, one of which sets the valve-mechanism before firing and the other of which controls the flow of fluid through the ports of the piston

during the recoil, the gun being arranged to
 50 cause one of said relative movements by its recoil and the other of said relative movements by its adjustment in elevation.

27. In a recoil device, the combination, with a recoil cylinder, a piston head therein
 55 and provided with ports, and a valve-mechanism arranged to control said ports, of a hollow piston rod connected to said piston head, and a valve-mechanism controlling member within the hollow piston
 60 rod, axially movable with relation thereto and arranged to move the valve-mechanism.

28. The combination with a cannon and fluid recoil-checking devices therefor, of means for varying the dimensions of the
 65 fluid-passage of said checking devices during recoil, and guide-surfaces extending longitudinally of the recoil devices and adapted to control the action of said means and cause the length of recoil to vary in
 70 accordance with changes in the elevation of the gun.

29. The combination with a cannon and fluid recoil-checking devices, of means including a plurality of elements, each
 75 adapted to control the recoil-checking devices and to cause said devices to act in a manner different from either of the others, and means for bringing said elements successively into operative position as the elevation of the gun is varied.

30. The combination with fluid recoil-checking devices for cannon, of means operating during the recoil and controlled by variations in the elevation of the gun
 85 for regulating the dimensions of the fluid-passage of said checking devices and adapted to vary said passage from its maximum to its minimum size at different distances in the rearward travel of the gun in
 90 recoil.

In testimony whereof I have affixed my signature to this specification, in the presence of two witnesses.

KARL VÖLLER.

Witnesses:

WILLIAM ESSENWEIN,
 ERNEST ANDRÉ.