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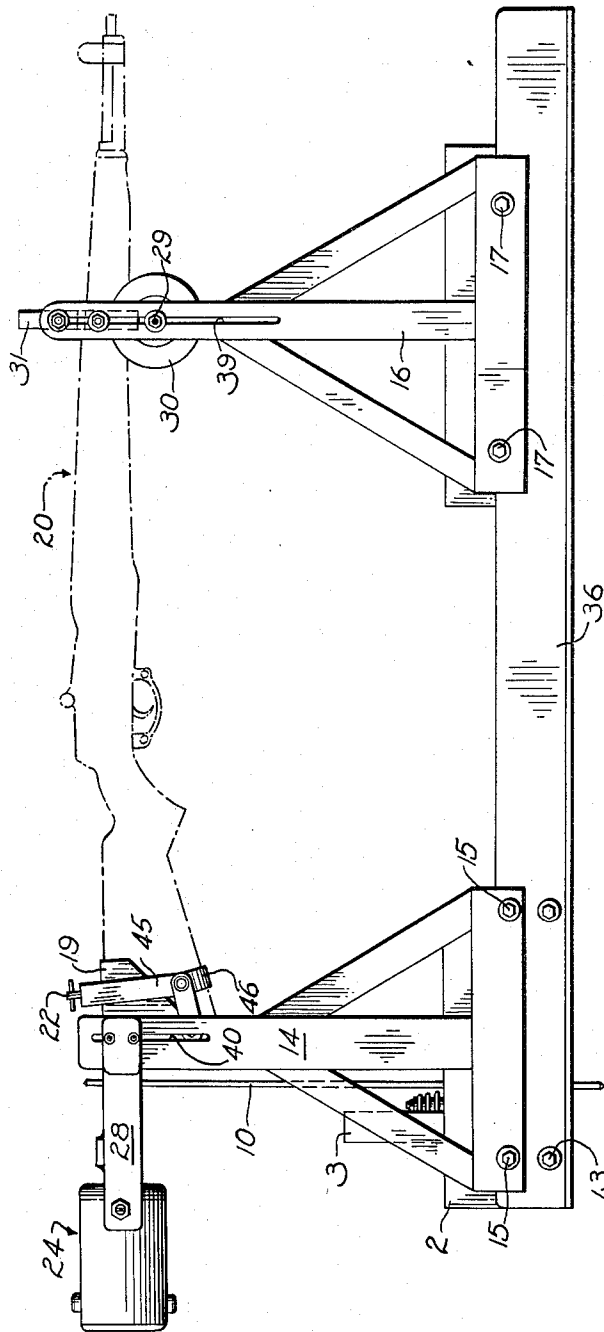
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VARIABLE RECOIL MOUNT

Filed June 9, 1952

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Fig. 2.

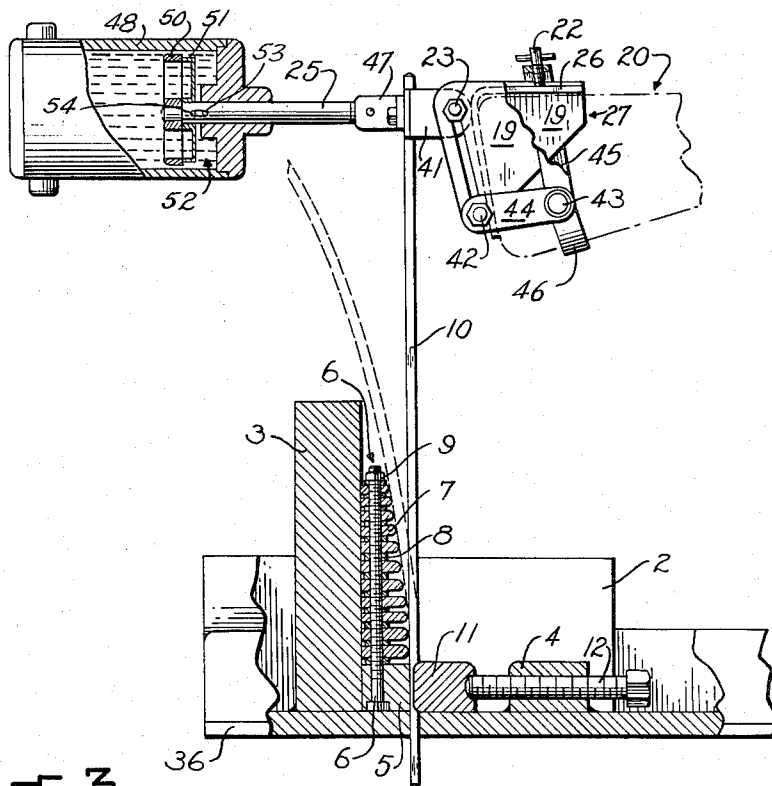


Fig. 3.

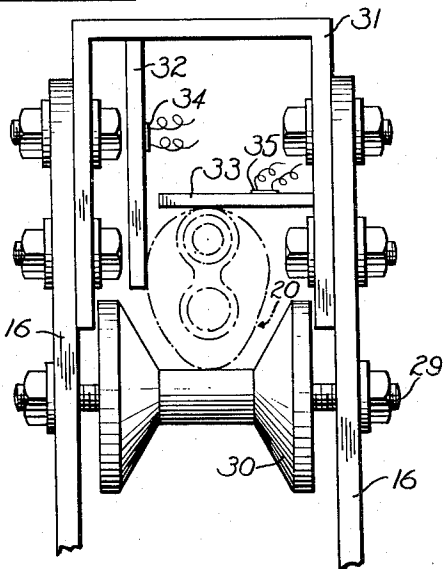
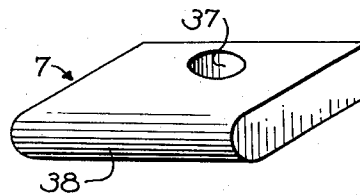


Fig. 4.



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VARIABLE RECOIL MOUNT

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Application June 9, 1952, Serial No. 292,598

9 Claims. (Cl. 73—167)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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

This invention relates to the testing of firearms and is particularly directed to mechanical means for supporting the firearms during tests.

In the experimental development of shoulder operated weapons, it is essential that a careful analysis be made of the forces produced during the firing thereof in order to determine their effects upon the operator and the function of the weapon. This is particularly true with the shoulder weapons wherein the recoil forces must be retained within prescribed limits, even to the sacrificing of other desirable qualities.

It is also important that the analysis of the recoil encountered in shoulder weapons include the full range of operating conditions to which the weapon may be subjected when issued to a body of men. For example, in the normal operation of shoulder weapons, the operator supports the weapon in such a way that his body opposes the recoil movement thereof. Consequently, the resistance offered to the rearward movement of the weapon varies with the weight of the operator and the amount of body flexure which is, of course, determined by the height and the firing position of the operator. It is obvious, therefore, that the recoil movement of a shoulder weapon is greater when fired by a tall man of slight build than by one that is short and heavily built. It is also greater when the operator is standing than when kneeling, and greater kneeling than when prone. It is also obvious that recoil is affected by cushioning of the clothing worn by the operator at the point he supports the weapon when fired.

The conventional means for measuring the recoil forces of shoulder operated weapons in test fire are time-displacement records of the recoiling parts of the weapon taken by a time-displacement camera, and strain gages. The means of operating these weapons when the measurements are taken comprise mechanical mounts and human shooters. Present day mechanical mounts are either of the spring backed or solid support types. The restriction placed upon the recoil movement of a weapon in the solid supports obviously make them of little value in analytical studies of recoil. The spring backed devices offer linear resistance and therefore are unable to simulate the recoil of a firearm in which there is produced a large displacement in the initial portion and a relatively small displacement in the final portion.

Moreover, difficulty is being experienced in obtaining the necessary recoil measurements through the use of shooters. Further, if the weapon is tested by only one operator, the measurements obtained will not truly reflect the full variation of conditions encountered when issued to the troops. Also, in the event of extensive firing, the resulting fatigue of the operator may very well produce a different handling of the weapon. On the other hand, the employment of a sufficient number of

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operators to simulate the various factors normally encountered in the field would obviously involve time-consuming and expensive procedures.

Accordingly, it is an object of this invention to provide mechanical means of supporting a firearm to simulate the actual recoil conditions encountered when fired from the shoulder of the operator.

It is another object of this invention to provide a test fixture for a firearm wherein the recoil and counter-recoil movements thereof may be controlled so as to obtain predetermined time-displacement relationships.

It is a further object of this invention to provide an improved means for measuring time-force relationships, along the longitudinal axis of the weapon, and laterally and vertically at the muzzle end thereof during recoil.

The specific nature of the invention as well as other objects and advantages thereof will clearly appear from a description of a preferred embodiment as shown in the accompanying drawings in which:

Fig. 1 is a side view of the mount of the present invention, showing a rifle supported thereby in position for test firing.

Fig. 2 is an enlarged fragmentary view of the mount, showing the cantilever beam and fulcrum unit thereof, partly in cross-section;

Fig. 3 is a front end view of means associated with the mount and employed to measure the recoil forces at the muzzle end of the rifle; and

Fig. 4 is a perspective view of one of the plates in the fulcrum unit.

As best shown in Fig. 2 there is provided a channel-like frame 2 and a rectangular post 3 which is fixedly secured as by welding within the sides of frame 2 and adjacent one end thereof. At the opposite end of frame 2, a cross member 4 is fixedly secured between the sides thereof in a manner similar to that of post 3. A rectangular block 5 is slidably disposed within the sides of frame 2 so as to be contiguous to the forward side of post 3. A threaded bolt 6 is fixedly mounted in block 5 so as to project upwardly parallel to post 3. A plurality of substantially rectangular plates 7 and spacers 8 are alternately stacked on bolt 6 for a purpose to be later shown. A nut 9 firmly secures plates 7 and spacers 8 onto bolt 6.

Each plate 7, as shown in Fig. 4, is provided with a hole 37 therethrough which is located at a fixed distance from the rearward edge thereof, and the distance from hole 37 to the forward edge 38 of each plate 7 is progressively less, from the lowermost to the uppermost. Thus, when properly stacked on bolt 6 the rear edge of each plate 7 contacts post 3 when block 5 is placed thereagainst and forward edges 38 form points of a parabolic arc which starts with the forward edge of block 5.

A flexible cantilever beam 10 is held securely erect against the forward face of block 5 by a suitably slotted second rectangular block 11 which receives the thrust of a screw 12 longitudinally mounted in cross member 4. Thus, block 11, beam 10, and block 5 are secured in frame 2 as a unit.

As shown in Fig. 1, a pair of longitudinally disposed angle iron members 36 form a channel-like base. Frame 2 is fixedly mounted, as by screws 13, between members 36 and at one end thereof. A pair of vertical support brackets 14 are fixedly secured to members 36 on either side of frame 2 as by screws 15. Forward of supports 14 and in alignment therewith a second pair of vertical support brackets 16 are fixedly secured to members 36 as by screws 17.

A substantially L-shaped bracket 26 is secured between the rear and upper sides of a pair of plates 19, as by welding, to form a stirrup member 27 adapted to receive the butt end of the stock of a rifle 20. A pair of U-

shaped straps 45 and 46 are pivotally joined at the respective free ends thereof by pin means 43 to encircle the forward portions of plates 19 and complete stirrup member 27. A pair of links 44 are pivotally joined at one end to pin means 43 and at the opposite ends to plates 19, as by pin means 42. A screw means 22 is transversely mounted through upper U-strap 45 to bear on bracket 26 so that when turned lower U-strap 46 will be drawn against the underside of the stock to hold the butt end of rifle 20 securely within stirrup member 27. A bolt 23 passes transversely through the upper rear portion of plates 19 to provide means of pivotally engaging plates 19 to a bracket 41 fixedly secured to the upper end of beam 10.

Rearwardly of beam 10 is a longitudinally acting hydraulic damping device 24 of conventional design having a forwardly projecting piston rod 25 pivotally secured to a yoke 47 fixedly mounted to beam 10 at approximately the same location thereon as bracket 41. Fixedly secured to the rear end of piston rod 25 within the interior of the cylinder portion 48 of damping device 24 is a suitably perforated circular plate 50 of slightly smaller diameter than the bore of cylinder 48. A cup-shaped circular member 51 of slightly smaller diameter than that of plate 50 is slidably mounted on the rear end portion of piston rod 25 with the cup-shaped side forwardly adjacent plate 50 to form a piston head portion 52. Cylinder 48 is fixedly secured to support 14 by a pair of oppositely disposed longitudinal arms 28. The rear ends of each arm 28 are pivotally secured to the exterior of cylinder 48 to permit the vertical rocking movement thereof necessary to prevent binding of piston rod 25 in cylinder 48 at various angles of reciprocation. The forward ends of each arm 28 are fixedly secured to support 14 but are arranged for vertical adjustment through the provision of slots 40. A longitudinally elongated slot 53 extends transversely through the rear end portion of piston rod 25 and is arranged to slidably receive a pin 54 extending transversely through the hub portion of cup-shaped member 51. Such construction permits plate 50 to separate from member 51 during the initial rearward movement imparted to piston rod 25 by the flexing of beam 10 in response to the recoil movement of rifle 20. As a result, the hydraulic fluid in cylinder 48 passes freely through the perforations in plate 50 and around the exterior periphery of member 51 and consequently does not impede the continued rearward movement of piston rod 25. However, upon the return or counterrecoil movement of piston rod 25, the resistance of the hydraulic fluid forces cup-shaped member 51 into contact with plate 50 thereby blocking the flow of fluid through the perforations therein. Since the only remaining passage for the hydraulic fluid is through the relatively small area between the exterior periphery of member 51 and the interior periphery of cylinder 48, the return stroke of piston rod 25 is appreciably delayed. The consequent damping effect on the recovery movement of beam 10 during the counterrecoil of rifle 20 can be readily adjusted by varying the amount of hydraulic fluid in cylinder portion 48 to simulate the desired lag in the recovery expected of a human shooter under the particular conditions of firing.

A rod 29 provided with threaded portions at both ends is secured by suitable screw means between support brackets 16 in vertical slots 39 therein. A roller 30 of spool-like conformation is axially rotatably mounted on rod 29 to provide support for the forward weight of rifle 20 resting thereon and to allow free longitudinal movement of the rifle when fired. Extending adjustably upward from support brackets 16 is a substantially U-shaped member 31. A flexible cantilever beam 32 is secured to the horizontal portion of member 31 to project downwardly to contact one side of rifle 20 for a purpose to be described later. A second flexible cantilever beam 33 is attached to one side of member 31 to project inwardly to contact the upper portion of rifle 20. Strain gages 34 and 35 are

suitably attached to beams 32 and 33, respectively, and are connected electrically to proper test equipment.

In testing, rifle 20 is fired by a shooter under desired conditions and a time-displacement record of the recoil is taken by suitable camera means. The rifle is then mounted in the device of this invention, the stock being secured to beam 10 and the handguard resting on roller 30 as previously described. Raising or lowering rod 29 will level the rifle, while damping device 24 is kept in alignment with the longitudinal axis of the rifle by vertical adjustment of brackets 28 in slots 40. Beam 33 is kept in contact with the upper portion of rifle 20 through adjustment of member 31. A selected combination of plates 7 and spacers 8 are mounted on bolt 6 and secured thereon by nut 9.

After the weapon is properly mounted as described, it is fired. The force of the recoil will flex beam 10 rearwardly. This flexure, however, is controlled by forward edges 38 of plates 7 which act as points of a rolling fulcrum to provide greater rigidity to beam 10 by shortening the effective length thereof in proportion to the deflection produced. A time-displacement record is taken of the recoil and compared with the original. If identical, it is obvious that the conditions existing in the original firing have been simulated. If not, the flexure points of beam 10 may be readjusted horizontally by substituting plates 7 of different size and vertically by substituting spacers 8 of different thickness until the proper combination has been obtained to produce the required results.

Once the fulcrum has been properly adjusted, the tests will proceed with the weapon in the mount and the results obviously will be the same as though fired by the original operator. Further, the fulcrum unit comprising block 5, bolt 6, plates 7, spacers 8, and nut 9 may be stored and used whenever the same firing conditions are again desired. It is, therefore, apparent that eventually there will be available a variety of fulcrum units to simulate most of the common conditions encountered in the field, thus eliminating the need for shooters except in unique circumstances.

Whenever the tests require a plurality of shots from an automatic weapon, damping device 24 attached to beam 10 allows free rearward motion of the weapon and a damped forward motion which may be adjusted to simulate the lag in position recovery provided by the shooter in counter-recoil movement. The extent of the forward and rearward movements is, of course, obtained from the time-displacement records.

It is clearly apparent that the device of this invention lends itself much more readily to exact measurements of the forces produced in the recoil of shoulder weapons, than when they are fired by the shooter. Since beam 10 and the fulcrum unit is unitarily contained within dismountable frame 2, finite measurements may be obtained of the longitudinal forces of recoil by removing frame 2 from angle iron members 36 and flexing beam 10 against the fulcrum unit by calibrated hydraulic pressure to the extent it flexes during recoil of rifle 20. A fish scale and weights might also be used, the scale attached to the end of beam 10 and weights placed therein to flex beam 10. This feature is particularly advantageous in the study of different rates of loading against the shoulder of the operator and when comparative evaluation of such accessories as muzzle brakes, muzzle checks and stabilizers is required. Further measurements may be obtained by attaching a strain gage (not shown) to beam 10.

When a shoulder weapon is fired, the forward end has the tendency to move laterally as the result of the rotation of the bullet induced by the rifling in the barrel. To measure this force, beam 32 is arranged to project downwardly into the path of lateral movement of rifle 20. Strain gage 34 attached to beam 32 and connected electrically to proper test equipment provides means for measuring the force. When a shoulder weapon is fired there is also a tendency for the muzzle end to lift. The

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force of this movement may be measured by strain gage 35 attached to beam 33 and connected electrically to proper test equipment.

It is apparent, therefore, that there is here provided an improved mechanical mount for shoulder arms which can readily simulate the curvilinear character of the time-displacement record taken of the recoil of a shoulder operated weapon and thereby duplicate the variety of conditions effecting such. Moreover, there is provided an improved means of measuring the forces produced during recoil.

We claim:

1. A test fixture for a firearm wherein the recoil and counterrecoil is controlled to obtain predetermined time-displacement relationships, comprising a front support fixedly secured to a channel-like base and arranged to slidably receive the front end of a firearm, a rear support fixedly secured to said base, a flexible cantilever beam vertically mounted to said base, means attached to the upper front end of said cantilever beam for pivotally supporting the rear end of the firearm, means controlling the flexing of said beam during the recoil movement of the firearm, and means for damping the flexing of said beam during the counterrecoil movement of the firearm, said damping means comprising a cylinder pivotally secured to the upper end of said rear support and a longitudinally movable piston pivotally secured to the upper end of said cantilever beam, said damping means being arranged to cooperate with said cantilever beam for simulating the actual recoil conditions encountered when fired from the shoulder of a shooter.

2. A test fixture for a firearm wherein the recoil and counter-recoil is controlled to obtain predetermined time-displacement relationships, comprising a front support fixedly secured to a channel-like base, said front support being provided with a rotatably mounted roller and arranged to slidably support the front end of a firearm thereby permitting longitudinal movement of the firearm, a rear support fixedly secured to said base and having a rearwardly extending bracket adjustably secured on each side thereof, a flexible cantilever beam vertically mounted to said base, means for damping the flexing of said beam during the counterrecoil movement of the firearm, said damping means comprising a cylinder pivotally secured between the rear ends of said brackets and a longitudinally movable piston pivotally secured to the upper front end of said cantilever beam for pivotally supporting the rear end of the firearm, and means controlling the flexing of said beam during the recoil movement of the firearm thereby simulating the actual recoil conditions encountered when fired from the shoulder of a shooter.

3. A test fixture for a firearm wherein the recoil and counter-recoil is controlled to obtain predetermined time-displacement relationships, comprising a front support fixedly secured to a channel-like base, said front support being provided with a rotatably mounted roller and arranged to slidably support the front end of a firearm thereby permitting longitudinal movement of the firearm, adjustable means for vertically positioning said roller whereby the firearm is horizontally aligned, a rear support fixedly secured to said base and having a rearwardly extending bracket adjustably secured on each side thereof, a flexible cantilever beam vertically mounted to said base, means for damping the flexing of said beam during the counterrecoil movement of the firearm, said damping means comprising a cylinder pivotally secured between the rear ends of said brackets and a longitudinally reciprocating piston pivotally secured to the upper rear end of said cantilever beam in alignment with the longitudinal axis of the firearm, a stirrup member fixedly secured to the upper front end of said cantilever beam and being provided with pivotal means for mounting the rear end of the firearm, and means controlling the flexing of said beam during the recoil movement of the firearm thereby

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simulating the actual recoil conditions encountered when fired from the shoulder of a shooter.

4. A test fixture for a firearm wherein the recoil and counterrecoil is controlled to obtain predetermined time-displacement relationships, comprising a front support fixedly secured to a channel-like base and arranged to slidably receive the front end of a firearm, said front support having a substantially U-shaped member invertibly disposed and adjustably mounted in the upper part thereof, a first strain gage flexibly mounted in said member horizontally disposed above the firearm whereby upward movement of the front end of the firearm will be registered thereby, a second strain gage flexibly mounted in said member vertically disposed on the side of the firearm whereby lateral movement of the front end of the firearm will be registered thereby, a rear support fixedly secured to said base, bracket means fixedly secured to the upper end of said rear support, a flexible cantilever beam vertically mounted to said base, means for damping the flexing of said beam during the counterrecoil movement of the firearm, said damping means comprising a cylinder pivotally secured to the rear end of said bracket means and a piston pivotally secured to the upper rear end of said cantilever beam for longitudinal movement in response to the flexure thereof, means attached to the upper front end of said cantilever beam for pivotally supporting the rear end of the firearm, and means controlling the flexing of said beam during the recoil movement of the firearm thereby simulating the actual recoil conditions encountered when fired from the shoulder of a shooter.

5. A test fixture as in claim 4 wherein the last mentioned means comprises a stack of plates and spacers alternately mounted on a vertically disposed bolt, the front edge of each of said plates being progressively positioned a lesser distance from the bolt than the preceding lower plate whereby said stack forms a parabolic arc.

6. A test fixture as in claim 4 wherein the second last mentioned means comprises, a mounting bracket secured to the upper front end of said beam, a pair of plates vertically disposed and pivotally mounted to said mounting bracket, an adjustable stirrup comprising a pair of pivotally joined U-shaped straps encircling said plates and arranged to receive the rear end of the firearm, said stirrup being pivotally mounted to said plates, an inverted L-shaped member secured between said plates whereby upward and rearward movement of the rear end of the firearm in said stirrup is prevented, and screw means arranged to removably secure the rear end of the firearm in said stirrup and against said member.

7. A test fixture for a firearm wherein the recoil and counterrecoil is controlled to obtain predetermined time-displacement relationships comprising, a front support fixedly secured to a channel-like base and arranged to slidably receive the front end of a firearm, a rear support fixedly secured to said base, a bracket extending rearwardly from either side of said rear support adjacent the upper end thereof, a flexible cantilever beam vertically mounted in said base, means attached to the upper front end of said cantilever beam for pivotally supporting the rear end of the firearm, means for damping the flexing of said beam during the counterrecoil movement of the firearm, said damping means comprising a cylinder pivotally secured between the rear ends of said brackets and a longitudinally movable piston pivotally secured to the upper end of said cantilever beam, said damping means being controlled to permit free rearward movement of said beam and adjustably damped forward movement thereof whereby the counterrecoil movement of the firearm as fired from the shoulder of a shooter is simulated, and means controlling the flexing of said beam during the recoil movement of the firearm thereby simulating the actual recoil conditions encountered when fired from the shoulder of a shooter.

8. A test fixture for a firearm wherein the recoil and counterrecoil is controlled to obtain predetermined time-

displacement relationships, comprising a front support fixedly secured to a channel-like base, said front support being provided with a rotatably mounted roller arranged to slidably support the front end of a firearm thereby permitting longitudinal movement of the firearm, adjustable means for vertically positioning said roller whereby the firearm is horizontally aligned, said front support having a substantially U-shaped member invertibly disposed and adjustably mounted in the upper part thereof, a first strain gage flexibly mounted in said member horizontally disposed above the firearm whereby upward movement of the front end of the firearm will be registered thereby, a second strain gage flexibly mounted in said member vertically disposed on the side of the firearm whereby lateral movement of the front end of the firearm will be registered thereby, a rear support fixedly secured to said base and having a rearwardly extending bracket adjustably secured on each side thereof, a flexible cantilever beam vertically mounted to said base, means for damping the flexing of said beam during the counterrecoil movement of the firearm, said damping means comprising a cylinder pivotally secured between the rear ends of said brackets in alignment with the longitudinal axis of the firearm and a piston pivotally secured to the upper rear end of said cantilever beam for longitudinal movement in response to the flexure thereof, a mounting bracket fixedly secured to the upper front end of said cantilever beam and being provided with pivotal means for mounting the rear end of the firearm, and means controlling the flexing of said beam during the recoil movement of the firearm thereby simulating the actual recoil conditions encountered when fired from the shoulder of a shooter.

9. A test fixture for a shoulder-operated firearm comprising a frame having upwardly projecting front and rear support brackets, a vertically disposed cantilever beam fixedly secured at one end in said frame, stirrup means

connecting the butt end of the firearm to the free end of said cantilever beam to effect flexure thereof in response to the recoil and counterrecoil movement of the firearm, an inverted U-shaped member fixedly secured to the upper end of said front support bracket over the muzzle end of the firearm, a horizontally disposed lever fixedly mounted to the side of said U-shaped member in position to resist to a predetermined extent the upward lift of the muzzle end of the firearm, a vertically disposed lever fixedly mounted to the top of said U-shaped member in position to resist to a predetermined extent the lateral drift of the muzzle end of the firearm, and a vertical stack of alternately disposed, individually replaceable plates and washers adjacent said cantilever beam, each of said plates projecting beyond said washers adjacent thereto by a lesser amount than said plate immediately therebelow whereby the edges adjacent said cantilever beam define a plurality of fulcrum points disposed in an upwardly progressive non-linear path, said cantilever beam adapted to cooperate with said horizontal and vertical levers for varying the recoil movement of the firearm in accordance with a predetermined time-displacement curve and thereby simulating the effect thereon of a human operator under selected conditions.

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