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R. NIEMANN

SPRING RECOIL MECHANISMS FOR MACHINE GUNS

Filed Dec. 24, 1938

Serial No. 247,699

3 Sheets-Sheet 1

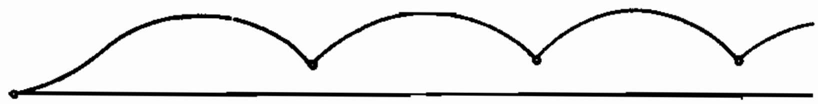


Fig. 2

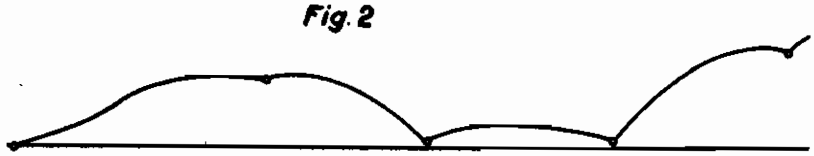


Fig. 3

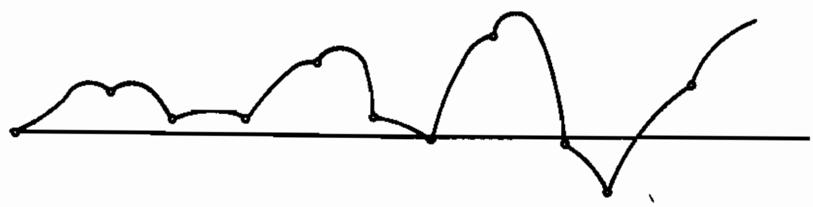
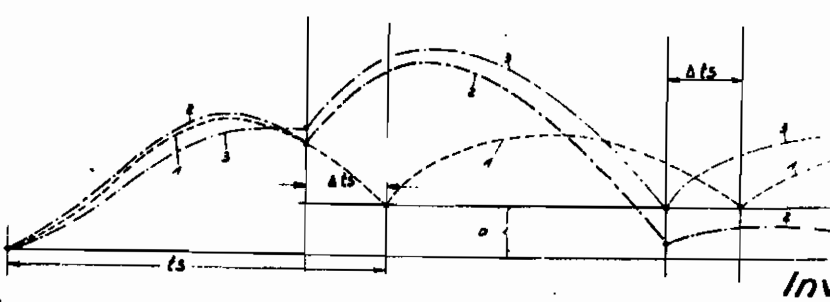


Fig. 4

Fig. 5



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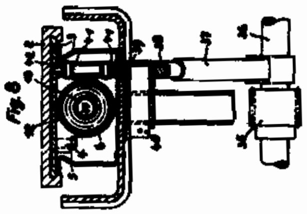

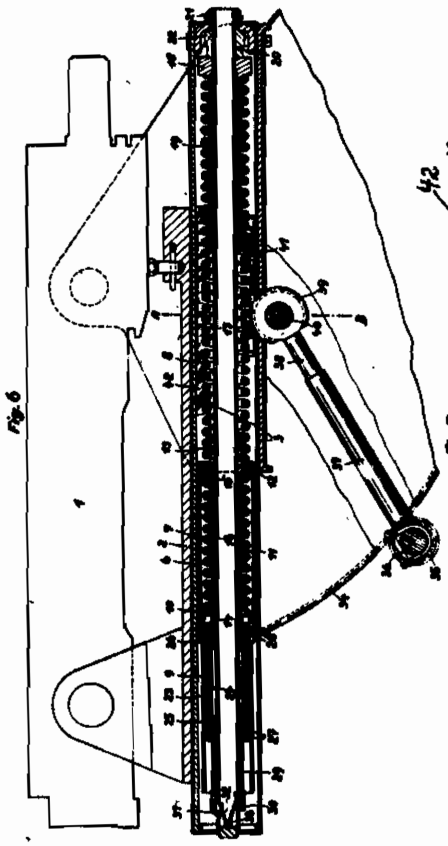

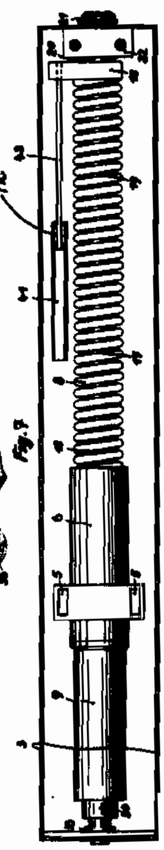

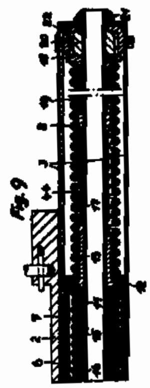

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Fig. 11

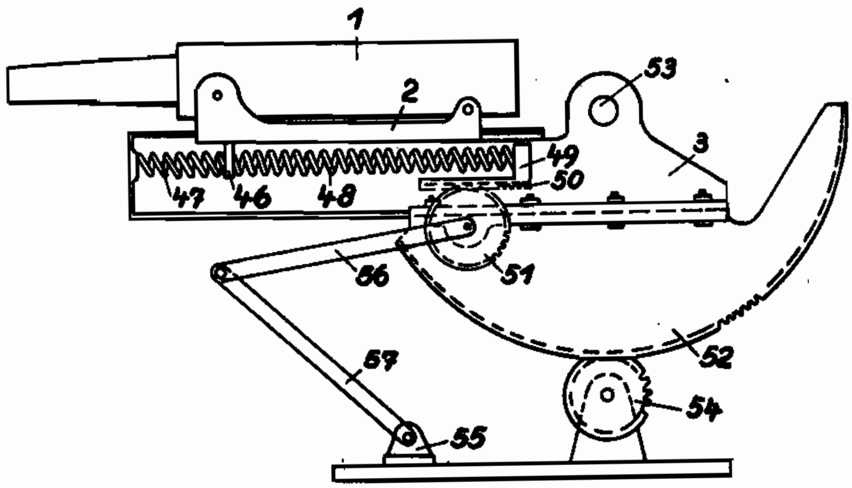
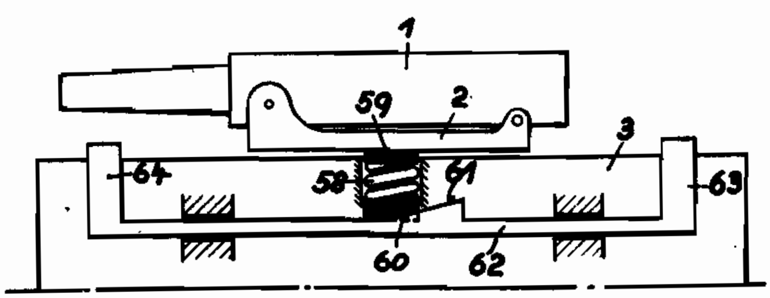


Fig. 12



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ALIEN PROPERTY CUSTODIAN

SPRING RECOIL MECHANISMS FOR MACHINE GUNS

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Application filed December 24, 1938

This invention relates to spring recoil mechanisms for machine gun carriages of the kind having a soft recoil spring the ratio of the natural vibration period of which to the firing interval is about 2:1 to 3:1. With such mechanisms the gun during continuous fire does not attain equilibrium and firing takes place in a condition of fluctuation which has certain advantages but also disadvantages such as irregular firing and sudden excessive recoils.

It is an object of the present invention to overcome the disadvantages while retaining the advantages of firing in condition of fluctuating spring action.

An important feature of the invention consists in combining with a soft spring mounting having a natural vibration period greater than the firing interval, a brake mechanism and preferably a friction brake. This makes it possible to regulate the speed of the gun casing in a manner to produce a uniform firing sequence without affecting the magnitude of the recoil energy.

A soft spring mounting makes necessary a considerable structural length since the cradle has to accommodate not only the recoil spring, and according to the invention a brake mechanism, but also a run-out spring. To overcome this disadvantage, a further feature of the present invention consists in utilizing a part of the long recoil spring also as a run-out spring thereby diminishing the overall length of the assembly and saving material. For this purpose the part of the recoil spring separated therefrom for use as run-out spring is tensioned in the slide or in a member connected thereto in such a manner that during recoil one end of the spring finds an abutment against the tensioning member, while in running out beyond the zero position the other end of the spring is moved from the tensioning member.

In connection with this novel spring arrangement it is possible to take into account the requirement that the spring mounting of the carriage must function perfectly in all positions of the gun. Since on elevating the gun from the horizontal position and recoil spring mounting is loaded by the weight of the recoiling parts, according to the degree of elevation, the position of rest and the path of movement of the slide will be displaced backwardly on the cradle so that the guides of the carriage must be correspondingly elongated. In this connection the invention provides a further feature according to which the abutment of the recoil spring is displaced further forwards in the carriage with increased elevation of the gun whereby the spring tension is increased to provide compensation for the weight. For this purpose a telescopic spindle may be provided jointed at one end to the pinion shaft of the elevating mechanism and at the other end terminating in a rotary toothed plate the teeth of which engage with teeth on a tension rod engaging the abutment for the recoil spring in the cradle.

According to another feature of the invention a simpler arrangement can be employed by dispensing with adjustment of the abutment in exact correspondence with the elevation of the gun. The above mentioned parts may then be omitted, and the rear portion only of the recoil spring, when it attains a determined tension due to the elevation of the gun, is held fixed. The front buffer spring then serves alone to take up the remaining recoil energy.

It has been found, however, that the thus obtained weight compensation of the gun is not sufficient to remove all irregularities, and that it is necessary for quite exact firing also to relieve the members sliding to and fro inside the gun under spring action, from the action of the additional weight components, in firing with elevation or depression. According to the invention, the carriage spring mounting is used for this purpose in such a manner that during rocking of the carriage structure and the gun connected thereto in the vertical plane, the carriage spring mounting is tensioned not only corresponding to the weight component of the gun and slide assembly, but receives either in itself or with the aid of additional springs, a supplemental tension corresponding to the weight component of the internal movable parts, whereby also the variations in the movements in the internal parts of the gun are compensated, that is, also these parts return to their initial position always with constant speed.

The brake mechanism employed according to the present invention preferably consists of a friction brake and uniform firing of the gun according to the invention is best obtained when during the whole run-out a greater energy is dissipated in the brake than in recoil. It should be observed, however, that in the first shot of a continuous fire series the total recoil impulse is converted into recoil velocity, while in all following shots the recoil impulse is diminished by the residual run-out velocity of the immediately preceding shot. The braking force therefore must be greater in the first shot than in the following shots of a continuous fire series.

To this end a further feature of the invention consists in reducing the braking force after the first shot of each continuous fire series, to adjust said force to the reduced recoil energy. This results in smaller fluctuations of power between run-out and recoil. Two brakes are thus provided one of which is operative only during the first recoil and is then rendered inoperative, while at the end of the run-out after the last shot of the series it is again brought into action.

The automatic connecting and disconnecting of the second or auxiliary brake may be accomplished by means of the gun slide by disposing suitable stops in the path of the gun slide, said stops being connected with the brake.

Several constructional examples embodying the invention of the application are illustrated in the accompanying drawings in which:

Figure 1 shows a time distance curve of a continuous fire series in a gun having soft carriage spring mounting without braking, assuming perfectly uniform functioning of the gun.

Fig. 2 shows the same continuous but with the usually present irregular functioning of the internal parts of the gun.

Fig. 3 shows the continuous according to Fig. 2 with reduced time coordinate scale.

Fig. 4 shows the time distance curve of a continuous fire series in a gun with soft spring mounting in combination with a brake mechanism according to the invention.

Fig. 5 shows the result achieved by means of the invention compared with that of an irregularly operating gun as in the prior art.

Figs. 6, 7 and 8 show the upper carriage with slide containing a built-in spring mounting and brake, the views being respectively in vertical section, in plan and in cross-section at the line A—B of Fig. 6.

Fig. 9 shows an arrangement of the carriage spring mounting with the front portion of the recoil spring used as compensatory spring when the gun is elevated.

Fig. 10 shows the arrangement of a friction brake with different braking force in the two directions of movement.

Fig. 11 illustrates diagrammatically a gun with automatically variable spring mounting of the carriage according to the elevation of the gun.

Fig. 12 illustrates diagrammatically the arrangement of two brakes in the gun, one of which is put out of action after the first shot and restored to operativeness after the last shot of a series.

On discharge of the gun having a soft spring the natural vibration period of which has a ratio of 2:1 relatively to the firing interval, but in which no brake is present, the zero position, as will be seen in Fig. 1, is not again attained after the first shot, as long as continuous fire lasts. As already pointed out above, it is assumed in the case of Fig. 1 that the parts in the interior of the gun operate perfectly uniformly, which is never the case in practice. Actually there is always obtained a time distance curve like that of Fig. 2 from which it is clearly seen that the separate firings occur at quite different distances from the normal. Under these conditions the accuracy of firing naturally suffers.

From Fig. 3 which shows the conditions of Fig. 2 with reduced time coordinate scale, it can be clearly seen that the irregularity is propagated and persists during the whole series of continuous firing.

Fig. 4 shows the behavior of a gun in which according to the present invention a soft spring is combined with a brake mechanism. The soft spring must be so tuned to the firing interval that during the shots following the first shot of a series the gun does not return completely to the position of rest. The brake mechanism has to be so adjusted that on the one hand it regulates the speed of the gun casing in the direction of a uniform firing sequence, and on the other hand without braking the recoil energy of a discharge during a firing interval. In this manner even with non-uniform functioning in the interior of the gun, uniform movement of the gun relatively to the cradle is obtained and the movements of parts inside the gun and the gun casing are prevented from falling out of step with those of the cradle.

The conditions in a gun mounting of this kind are entirely different from those in a gun having a stiff spring mounting instead of a soft spring mounting and brake. With a stiff spring mounting movements inside the gun have no importance because the gun remains at rest during about two thirds of the whole firing interval, since the recoil and the run out terminate after a third of the firing interval. During the long period of rest the parts in the interior of the gun come to rest so that they have no effect upon the following shot. With a stiff spring mounting, therefore, the problems solved by the invention of the application, are not present. The advantages achieved by the present invention are particularly notable from contemplation of Fig. 5 which shows in superposed relation the previously described time distance curves.

Curve 1 which shows the ideal case of the spring tuned exactly to the firing interval shows that each shot is fired at the same height a before the equilibrium position of the gun.

If fluctuations in the periods of movements inside the gun take place, then according to curve 2 the shots are fired at different distances before the equilibrium position. It is assumed, for example, that the second shot is fired by a time Δ^ts earlier than in the normal case. After this shot there then occurs a violent recoil because the speed of the gun at the instant of firing was less than the normal. At the third shot the speed of the gun, on the other hand, is greater and the succeeding recoil is less violent.

If one now applies a brake mechanism according to the invention, there is obtained a movement according to curve 3 of Fig. 5. The brake retards the too-violent movement after the second shot and brakes the recoil energy not transmitted in the necessary proportion, so that the third shot will be fixed again in the normal position of the gun (height a). Afterwards the regularity of the shot-firing will be given.

In order to attain the result intended with the invention the gun may be arranged according to the example shown in Figs. 6 to 8.

The gun 1 is rigidly secured to the slide 2 moving to and fro on the cradle 3 of the carriage. The disconnectable connection of the slide 2 with the cradle 3 will be made by means of two pins 4, which may have a rectangular cross section, which pins 4 may be inserted into corresponding holes 5 of the sleeve 6 forming the movable abutment of the buffer spring 7 serving as recoil and run-out spring as well as of the recoil spring 8. Into the front end of the sleeve 6 completely enclosing the buffer spring the brake-cylinder 9 is rigidly inserted, and the buffer spring 7 supports against this brake-cylinder 9, a spring-plate 10 being interposed. The rear abutment of the buffer-spring 7 is formed by a flange of the spring-guide 11, and this flange supports against a ring 12 of the sleeve 6 if the gun is running-out beyond the zero-position, in all other cases against the flange of the front-guide 13 of the spring 6. At the rearmost end the spring 8 supports against the flange 18 of the guide 19 being mounted on the supporting tube 17. The fixed connection of the supporting tube 17 with the cradle 3 is obtained by means of nuts 25 and 21 on both sides of the rear wall of the cradle.

In front of the springs 7 and 8 and internally of the brake cylinder 8 there is arranged on the supporting tube 17 a friction brake consisting of a brake lining 23, a solid bushing 24 with tapered contact surfaces, and a pair of actuating wedges 25 and 26. Externally of these parts lie sets of disk springs 27 and 28 which are tensioned on the supporting tube between the collar 14 and a sleeve 29 by means of a nut 30. By turning the nut 30 the tension of the disk springs and therefore the braking force is adjusted. To prevent unintentional turning of the nut a locking member 31 is provided which is pressed by a spring 32 into an internal groove in the nut 30. A pin 33 retains the spring 32 and prevents turning of the supporting tube 17.

The elevating gear for the gun comprises a toothed ring 34 on the cradle which is engaged by a pinion 35 on a shaft 36 journaled in the under-carriage. The pinion shaft 36 has jointed thereto the outer tubular member 37 of a telescopic spindle, the inner telescopic tube 38 of which terminates in a toothed plate 39 which is rotatably mounted on the pivot 40 of the upper carriage, below the cradle and its suspension. The toothed plate 39 meshes with teeth of a plate 41 which is slidable in a guide 42 and is connected by a tension rod 43 to the flange 18, whereby movement of the plate 41 brings the flange 18 against the guide 19 and displaces the rear abutment of the spring 8 forwardly. When the cradle is depressed from the zero position, then the tension rod 43 slides back freely in the dovetail groove of the flange 18 held by the nut 20, so that the spring tension is not changed.

The same result of modifying the spring tension can be obtained in a somewhat simpler manner as shown in Fig. 9. In Fig. 9 it is assumed that the gun is elevated and is recoiling. Instead of the parts 37 to 43 shown in Figs. 6 to 8 there is provided a tube 44 inserted over the supporting tube 17. This tube constitutes an extension of the rear guide 19 of the spring 8 and is arranged in the recoil path of the front spring guide 13. The distance between the front end of the tube 44 and the rear edge of the guide 13 is such that it never becomes zero in slide recoil during horizontal firing. It is only after the gun has assumed a determined inclination that the tube 44, on recoil of the slide, contacts with the guide 13 whereby the spring 6 then becomes inoperative. After this the buffer spring 7 alone is tensioned to completely take up the recoil energy. In this manner the advantage is achieved that in spite of the greater loading of the spring in elevation firing, the reciprocation of the slide relatively to the cradle remains substantially the same as in horizontal firing.

The friction brake shown in Fig. 6 is arranged on the supporting tube 17 of the cradle between two disk springs of equal strength. With equal angles of inclination of the actuating wedges 25 and 26, the friction force of the brake is the same in run out and recoil. Since the fluctuation forces on the carriage are less when the braking force is greater in run out than in recoil, it may be of advantage to resiliently mount on the supporting tube 17 only the actuating wedge 26 which is operative in recoil. This is achieved as shown in Fig. 10 by providing a helical spring 45 which abuts on the collar 14 of the tube 16 welded or otherwise fixed to the supporting tube 17. By using a spring 45 of suitable power and suitable angles of inclination of the contact surfaces between the wedges 25 and 26 and the solid bushing 24, the ratio of braking force in run-out and recoil can be adjusted as desired.

In the above-described examples, only the weight components due to elevation of the gun have been used to modify the spring tension, and according to the example shown in Fig.11, means are provided which take into consideration also the conditions in the interior of the gun and which provide a further increase of the spring tension to compensate for the altered conditions in the interior of the gun resulting from its elevation.

In this case also the gun 1 is mounted on the slide 2 of the carriage 3 and reciprocates with said slide during firing. On the slide 2 there is provided a projection 46 disposed between a buffer spring 47 and the slide run-out spring 48. The spring 48 abuts at its rear end against an abutment 49 which is adjustable in the axial direction of the spring and which carries teeth 50 on its lower face. These teeth engage a toothed segment 51 which is pivoted to a toothed ring 52 carried by the carriage 3. The toothed ring 52 is rotatable about a shaft 53 and is actuated by a pinion 54 to elevate the gun. The toothed segment 51 is connected with a fixed bracket 55 by means of a pair of links 56, 57 which lie at an acute angle to each other when the gun is in horizontal position. The link 56 moves about the pivot of the toothed segment 51 and is fixed thereto so that angular movement of the link 56 is accompanied by an equal angular rotation of the segment 51. If the gun is now elevated for oblique or high-angle fire, the toothed segment 51 on the carriage moves through a corresponding arc about the pivot 11. In this movement the links 56 and 57 diverge so that finally the abutment 49 of the carriage spring is correspondingly shifted forwardly. The gear ratio is such that the initial tension of the carriage spring is increased not only by the supplemental amount required to compensate the weight components rendered operative by elevation but also receives a further tensioning sufficient to eliminate the loading which would otherwise be caused by the internal parts of the gun as a result of its elevation.

The above-described mechanisms are capable of accomplishing the purpose of the invention in the second and following shots of a continuous fire series. During the first shot of such a series, however, different conditions are present and therefore the braking effort according to the present invention has to be greater than in the following shots. Means for achieving this are shown in Fig. 12.

As in the previous examples, the gun 1 recoils on the slide 2 in the carriage cradle. The brake, which operates as in the previous example, is illustrated by the brake lining 59 acted upon by a spring 58. It will be understood that by changing the tension of the spring the magnitude of the braking effort can be varied. For this purpose the lower end of the spring bears against a bevelled abutment 60, the bevel of which cooperates with a ramp 61 on a rod 62. The rod 62 is provided at its ends with stops 63, 64 extending into the path of movement of the slide 2. In the position of rest, the rod 62 assumes a position in which it is pushed fully forwards so that the inclined surfaces 60 and 61 are in maximum engagement. After the first shot, and only after the first shot, the slide 2 strikes against the stop 63 and thus forces the rod 62 rearwardly so that the ramp 61 is withdrawn from below the bevel of the spring abutment, whereby the tension of the spring and consequently the braking effort is reduced after the first shot. After the last shot when the run-out is no longer interrupted by a further shot, the gun returns to initial position, that is further forwards than during continuous firing, in which position the slide 2 encounters the front stop 64 of the rod 62 and carries the latter forwardly under the inclined surfaces 60, 61 are again in maximum cooperation. This restores the brake to condition of maximum braking effort, with which it is ready to operate on the first shot of the next series.

In the manner herein-before described the machine gun according to the invention is equipped with a soft spring mounting and a brake mechanism capable of giving in all cases uniform sequence of fire with resulting accuracy of firing.

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