Dec. 8, 1942. J. F. HABERLIN 2,304,566

FIRE CONTROL MECHANISM

Filed Dec. 2, 1939 3 Sheets-Sheet 1

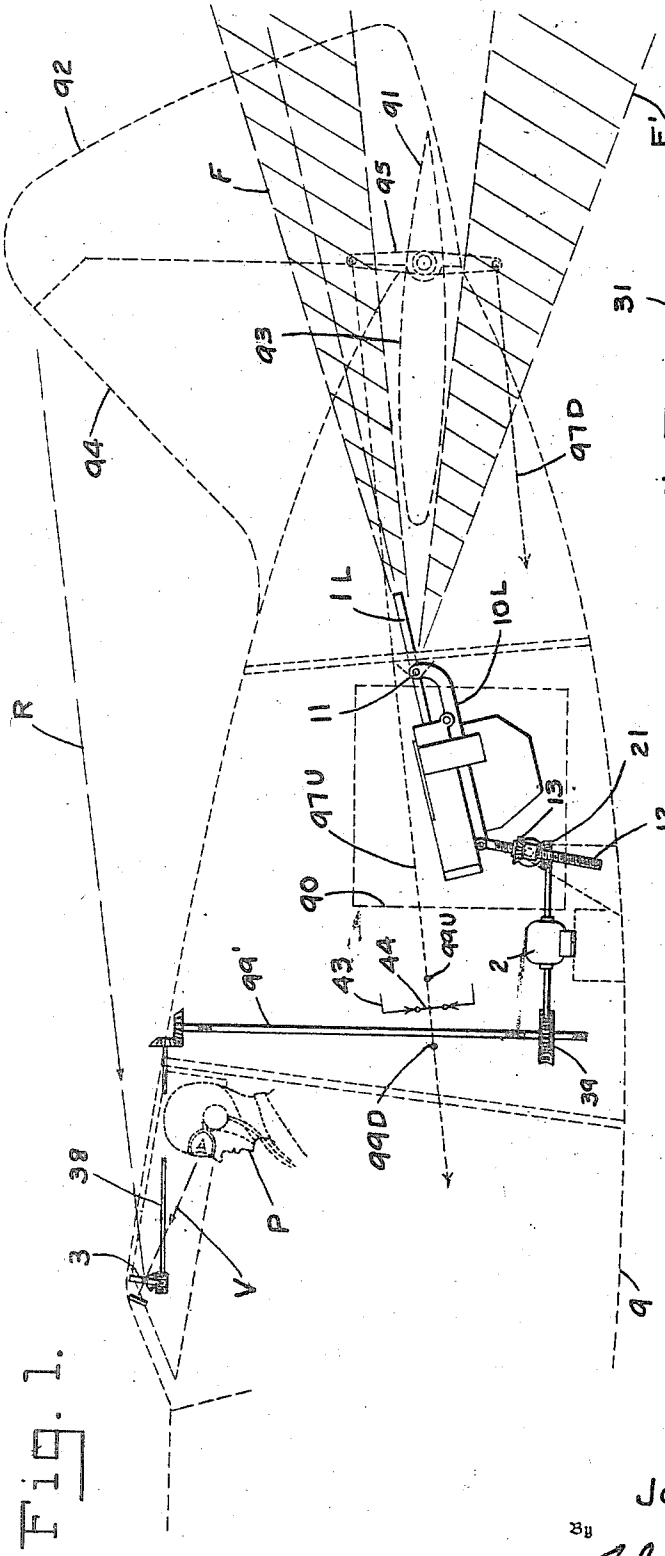


Fig. 1.

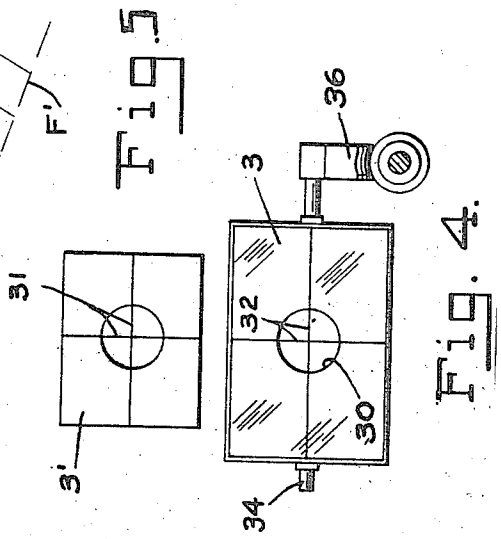


Fig. 4.

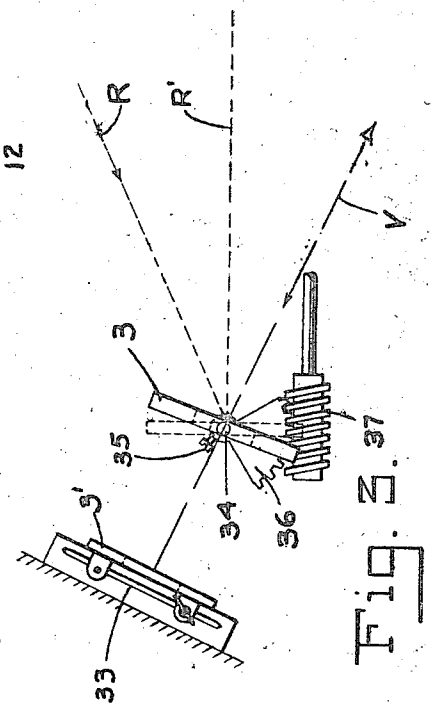


Fig. 5.

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FIRE CONTROL MECHANISM

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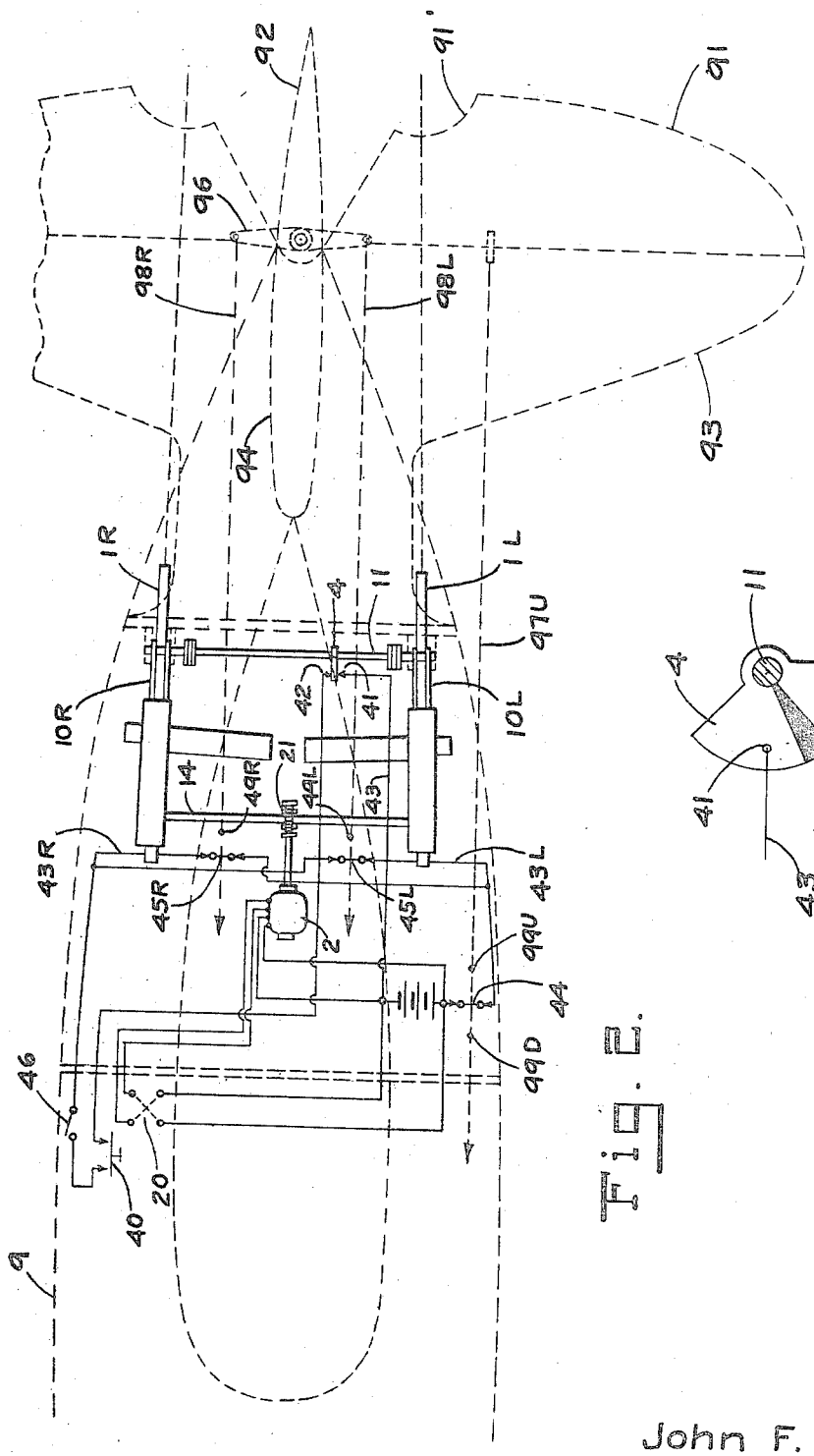


Fig. 2.

Fig. 6.

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FIRE CONTROL MECHANISM

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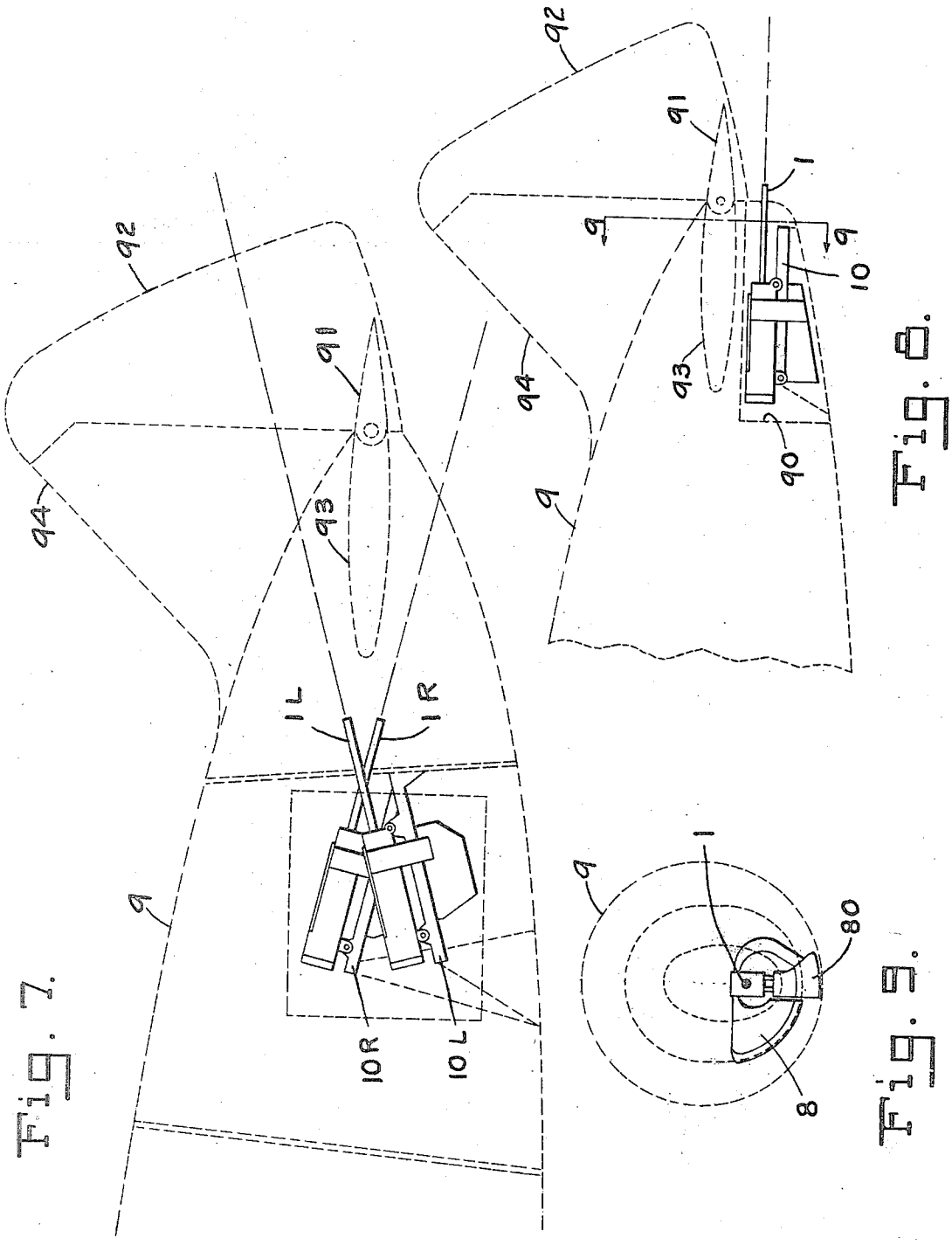


Fig. 6.

Fig. 7.

Fig. 5.

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Patented Dec. 8, 1942

2,304,566

UNITED STATES PATENT OFFICE

2,304,566

FIRE CONTROL MECHANISM

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Application December 2, 1939, Serial No. 307,273

5 Claims. (Cl. 89—27)

This invention relates to military airplanes, and more particularly to a single-seated airplane of the pursuit or fighter type. The invention is concerned with the provision of means whereby the pilot of such a single-seated fighter may protect himself from attacks from the rear.

Single-seated military planes are normally armed with one or more machine guns, directed forwardly, since such airplanes are intended primarily as fighters to pursue and attack larger airplanes, such as bombers, while in flight, and they are normally so fast that reliance is placed upon their speed to avoid attacks upon them from the rear. However, whenever a group of bombing airplanes convoyed by pursuit planes is attacked by enemy pursuit planes, there immediately ensue combats between individual pursuit planes of approximately equal speed and maneuverability, and in such dog fights each fighter, knowing that the other has only forwardly directed machine guns, endeavors to keep out of the forward line of fire of his opponent, and instead to place himself on the tail of his opponent, where he can destroy his opponent with forwardly directed fire from his own guns. The fighter who permits an opponent thus to gain the advantage of a position on his tail has no defense other than skillful maneuvering. Occasionally, too, an airplane or a patrol may be attacked by enemy airplanes which, without being seen, attain a position on their tail.

It is the principal object of the present invention to afford to such a single-seated fighter plane the advantage of a rearwardly directed gun, whereby should its pilot find an opponent upon his tail, he can destroy the opponent instead of being himself destroyed, or being forced to maneuver to escape attack.

It is known in larger airplanes to provide rearwardly directed guns, and such guns are adjustable for aiming, but almost always heretofore it has been necessary to carry an extra gunner to aim and fire such rearwardly directed guns. This constituted an added burden, and if such added weight was to be carried it would be better to carry additional ammunition or fuel, or both, and without such added weight the ceiling, rate of climb, maneuverability and other performance characteristics of the airplane could be improved. It has been proposed to mount a rearwardly firing gun in a single-seat airplane, and to adjust it to fire in either of two positions; for aiming, two separate aiming means have been provided, one fixed with relation to one position of the gun, and the other fixed with relation to the alternative position of the gun. This affords some measure of protection to the pilot, but still if an enemy airplane attacks from the rear and within the necessarily fairly wide angle between the two firing positions, the only protection for the pilot is to maneuver. Maneuvering breaks up formations, and destroys the protection of the mass of fire of the whole formation, besides interrupting forward progress and perhaps leaving a convoyed formation open to attack. It is therefore preferable so as to arrange the fire power of such fighter airplanes that they may, without breaking formation, deal with any enemy approaching from the rear throughout the whole of any angle which permits the enemy to bring to bear effective and sustained fire from his forwardly-firing guns. However, it has not been deemed possible heretofore, so far as I am aware, to provide a rearwardly directed gun in a single-seated fighter, and to arrange sighting means for such a gun, properly coordinated therewith, in such a way that the single occupant of the airplane could effectively fire the gun at an opponent on his tail. The provision of means to this end is the primary object of this invention.

If such a gun were a fixed gun, it would probably fire either above or below the elevator and horizontal stabilizer, although, indeed, two such guns might be carried, one pointing above and one below these control surfaces; but in any event, if such rearwardly directed guns were known by the enemy to be fixed in position, or only capable of firing in one of two divergent directions, their line or lines of fire would be avoided. It is therefore a further object of the present invention to provide means to adjust such rearwardly directed guns in a single-seated military airplane, for aiming them, and, moreover, to coordinate the adjustment of the guns with an adjustment of the sighting means, to the end that the two may always be kept automatically in proper coordination. It is then possible to aim the rearwardly directed guns, either by maneuvering the airplane, or by adjusting the guns relative to the airplane, or both, with the result that the field of fire rearwardly is made sufficiently wide in angle as to afford effective protection, especially when it is considered that the two opponents will have airplanes of approximately equal speed.

The weight of such rearwardly firing guns and their ammunition being appreciable, as compared to the capabilities of such a single-seated fighter, they will normally be located as close as possible to the airplane's center of gravity, and

almost certainly close to the longitudinal medial axis of the airplane. In such a position their line of fire will normally lie close to one of the control surfaces of the empennage, and some one or more of the swingable control surfaces may at times intersect the line of fire. Indeed, if the guns are adjustable for aiming, their field of fire may encompass fixed control surfaces, such as the vertical fin or the horizontal stabilizer, and in addition, in certain swung positions of either the elevator or the rudder, or both, these may intersect the field of fire of the gun in some given adjusted position of the gun. It is desirable to restrict the field of fire of the gun to the slightest degree, and to keep the guns capable of action to the greatest possible degree, yet it is essential that the gun be prevented from shooting away the control surfaces of its own airplane. On the other hand, it is scarcely possible for the pilot to take care to cease firing during times, often but momentarily, that there is conflict between the position of a control surface and the line of fire of the gun. Accordingly it is an object of the present invention to provide means interconnecting the various controls for the control surfaces, the controls for firing the gun, and the controls for adjusting the gun, to the end that automatically and in any position of the control surfaces or of the gun, any given gun is prevented from firing when any control surface, fixed or movable, lies within the field of fire of that gun, whatever may be the gun's position or the position of such control surface.

Indeed the advantages of such automatic interdicting means are not confined only to single-seated airplanes nor to rearwardly firing guns, and it may be stated in broader terms that it is an object of the present invention to provide means automatically operable which will prevent the firing of a gun whenever, by reason of adjustment of the gun in aiming, or by reason of movement of a control surface or like movable member of the airplane, such element of the airplane comes within the field of fire of the gun, yet which permits firing of the gun, without restriction and without interdiction, at all other times.

It is a further object of the invention to provide an installation of this sort which may be conveniently mounted and supplied with ammunition, and from which the discharged cases and links may readily be removed, and indeed to provide an installation which is capable of cooperating with the structural details of the airplane in various ways, and without affecting the aerodynamic characteristics of the airplane.

With these and other objects in mind, as will appear hereafter, my invention comprises the novel gun and mount therefor, and the novel combination thereof with sighting means, as and for the purposes set forth above, and the novel combination of such a gun and sighting means with the controls and control surfaces of the airplane whereon it is mounted.

In the accompanying drawings the invention is shown largely in diagrammatic form, and in several possible arrangements.

Figure 1 is a side elevation of an adjustable gun installation as applied to a single-seated military airplane, and Figure 2 is a diagram and view in plan, illustrating principally the interrelation of controls.

Figure 3 is a side elevation of a suitable sighting device, and Figures 4 and 5 are elevations of component parts thereof.

Figure 6 is an elevation of a safety control having to do with the adjustment of the gun for aiming.

Figure 7 is a view similar to Figure 1, showing a modified arrangement and illustrating fixed guns.

Figure 8 is a side elevation of the tail portion of such an airplane, showing a further modification of the arrangement of such a gun, and Figure 9 is an end view of the same, taken substantially from the viewpoint indicated by the line 9—9 of Figure 8.

As may be seen in Figures 7, 8 and 9, the gun or guns, indicated at 1R and 1L, may be fixedly mounted. In Figure 7 each gun is carried upon a cradle 10R or 10L, fixedly positioned and supported within the tail end of the fuselage 9, the guns firing rearwardly through suitable tunnels or apertures in the skin (not shown) in such manner that the gun 1L, for instance, fires above the elevator 91 and horizontal stabilizer 93, and the other gun 1R fires below the fixed and movable control surfaces named. Likewise these guns are so arranged that their lines of fire clear the rudder 92 and the vertical fin 94. In Figures 8 and 9 only a single fixed gun 1 is employed, this being positioned within the fuselage at its extreme tail end, firing beneath the horizontal stabilizer 93 and the elevator 91, and as before, avoiding the rudder 92. In the form shown in Figure 8 the tail end of the fuselage is recessed, as indicated at 90, and the gun with its ammunition container, or the ammunition container alone with the case and link receiver, complements and completes the streamline contour of the fuselage by filling the recess thus formed. As seen in Figure 9, the ammunition container 8 and the case and link receiver 80 are each so formed that they conform closely to the streamline contours of the skin of the fuselage, and complete this streamline form, when they are in place. Thus they are accessible from the exterior of the grounded airplane.

In the remaining views the guns are adjustable in elevation, and if dual guns are employed preferably both are directed substantially alike, that is, both are either upwardly directed or downwardly directed at the same angle, although it is not outside the scope of my invention to arrange them relatively at a slight vertical angle—such an angle, for instance, as will permit one to fire over or under the horizontal stabilizer as the other, during adjustment, is blanked thereby. In such manner one gun or the other is always ready for action, notwithstanding the disabling of the other (as later described) during adjustment. However, their lines of fire may converge rearwardly, as seen in plan, so that both may be brought to bear at a given aiming point located a known distance to the rear of the airplane. The cradles 10R and 10L whereon these guns are carried, and by reason of which they are adjustable, are carried upon a transverse rock shaft 11, and adjustment of both guns about this rock shaft is accomplished in unison by an arrangement such as the jack screw 12 and the rotatable nut 13 (see Figure 1), the nuts being rotated by suitable drive means 21 on a transverse shaft 14 which in turn is driven from a reversible motor 2.

The pilot, shown at P, is usually seated in a small cockpit, where there is little chance for him to move about or change his position to any considerable extent, and he must maintain observation to the front. In modern military airplanes he will normally be within a hooded cock-

pit. However, it is possible to support within the hood, in advance of the pilot and in such position that he need shift his line of vision but slightly, sighting means which include a rear-view mirror 3. If desired, or if necessary, he may have two sighting means, one for each of the guns 1R and 1L. Any convenient sighting means may be employed in conjunction with such a mirror, or the sighting means may incorporate such a mirror. Purely as a convenient and suitable means to the end in view, I have illustrated the sighting means which I shall shortly describe. Before describing it, however, let me point out that the rear-view mirror 3 is so positioned relative to the line of vision V from the pilot's eye, and with relation to the direction assumed by the barrel of the gun, that a target, such as an airplane on the tail of the pilot's airplane, which is seen within the mirror 3 (particularly when it arrives at a given position in that mirror), is in the line of fire of the gun.

The sighting means herein shown includes, in addition to the rear-view mirror 3, a pair of cross hairs 31, and the mirror has a central aperture 30, and similar cross hairs, 32. The cross hairs 31 are spaced from the cross hairs 32 in the line of vision V of the pilot, so that the pilot, looking along the line V, picks up his target in the mirror 3, and keeps the cross hairs 31 and 32 in alignment, in the line V. When these cross hairs are centered on the target which he sees in the mirror 3, by reflected vision along the line R, the pilot knows that the target is in line of fire of his gun. The spaced cross hairs 31 and 32 in effect fix the line of vision V of the pilot so that it does not vary by reason of a different positioning of his head. Incidentally, since the height of pilots will vary, suitable adjustment may be provided to accommodate this, and to that end the plate 3', carrying the cross hairs 31, has been shown as adjustably mounted at 33 for movement transversely of the line of vision. In like fashion the mirror 3 may be tilted about a transverse axis 34 by means such as the set screw 35, and thus it may be adjusted to bring it into proper coordination with the position of the gun barrel. The target is then seen along the new line of reflected vision R'.

It is necessary that the sighting means be movable in synchronism with the gun as the latter is adjusted for aiming, and in such manner that the coordination between the mirror 3 and the gun is always maintained in all adjusted positions. Accordingly means are provided to accomplish such coincident and corresponding movement. To such ends a worm segment 36 may be secured upon the rock shaft 34, with a worm pinion 37 in mesh therewith, and this worm pinion 37 is suitably connected to the motor 2 or to the adjusting means for the guns themselves, or to means which are adjustable in accordance with adjustment of the guns. The precise connection is largely immaterial, the desideratum being connections which coordinate the adjustments of the gun and of the sighting means. As herein shown, in purely suggestive or diagrammatic fashion, the pinion 37 is carried upon a shaft 38, which by positive transmission means 39, correct as to extent and direction of movement, is connected to the motor 2, so that as the motor 2 rotates the nut 13 to adjust the guns, the motor is at the same time adjusting correspondingly the position of the sighting mechanism typified by the mirror 3. The precise details of this will vary with each installation, and are readily determined once the characteristics of a given installation are known.

As may be seen in Figure 1, the upper and lower limits F and F' of the field of fire of the guns encompass the fixed horizontal stabilizer 93 and the swingable elevator 91. The guns are normally fired through electrical means, and it is convenient to provide in the main firing circuit 43 contacts 41 and 42, disposed in contact with and at opposite sides of a conductive plate 4, carried upon the rock shaft 11, but including an insulating segment 42. The insulating segment 42 is so positioned, and is so coordinated with the movement of the gun and the location of the control surface, that it interrupts the current in the firing circuit to the guns during such time as the gun is swinging past the fixed control surface 93.

If the elevator may swing into the guns' line of fire, it may be notched out to avoid being hit, as at 91'. If this is not done, then it is of course essential to prevent firing of the guns whenever the elevator 91 is swung upward or downward into the guns' field of fire, yet it is desirable to permit firing of the guns at all times except when the control surface swings so far up or down as to be in danger of entering the guns' instantaneous line of fire. Accordingly, in such an arrangement, there are means provided, interconnecting between the firing controls of the guns and the controls for the elevator 91, so that firing of the guns is further interdicted by interfering movement of the elevator.

The normal controls of the elevator include a mast 95 and cables 97U and 97D extending forwardly to the pilot's cockpit, or their equivalents, connected to the usual control stick there present. Within the main gun-firing circuit 43 is included a normally closed and self-closing switch element 44 which is positioned adjacent one of the cables 97U or 97D, and upon such cable, for instance the cable 97U, properly spaced at either side of the switch element 44, are provided stops or balls 99U and 99D. Upon sufficient movement of the cable 97U forward or rearward as to cause the elevator 91 to swing upward or downward into the line of fire of the gun, one of the balls 99U or 99D will engage the switch element 44 and will move it to break the firing circuit through the lead 43. Neither of the guns can fire so long as the switch 44 is open, but this switch is arranged to be closed automatically, as by spring means (not shown), immediately upon movement away of the deflecting ball 99U or 99D.

The guns 1R and 1L may be so located that they fire at opposite sides of the vertical fin 96, but may fire in a line so close to the fin that the rudder 92 may in some positions enter the line of fire of one or the other of the guns. In similar fashion, then, provision must be made to disable the interfering gun at such times, for it is scarcely feasible to notch out the rudder throughout the distance subtended by the guns' angle of fire. The rudder 92 is normally swung by a mast 96, operated by cables 98R and 98L, or the equivalent, extending forwardly to the normal rudder bar (not shown) in the pilot's cockpit. Upon each of these cables 98R and 98L there is provided a stop or ball 49R or 49L, corresponding to the balls 99U and 99D, which engages a switch element 45R or 45L in the shunt firing circuit 43R or 43L of the corresponding gun 1R or 1L. In the same fashion as previously described, sufficient movement of the control ca-

ble 98R or 98L will break the firing circuit of the gun on the side towards which the rudder is swung, but will keep the other gun in action through its individual shunt circuit 43R or 43L. The opened shunt is kept open until the rudder has again swung back sufficiently toward neutral position that it is out of the line of fire of this particular gun, and then closes automatically. In this way both guns are kept in action to the maximum degree possible, and only one gun need be disabled momentarily by reason of rudder action.

These various safety arrangements operate only during such brief times as there is danger that firing of the guns would carry away some of the control surface of the airplane in which they are mounted, and these safety switches are immediately self-closing upon the removal of the swung control surface out of the line of fire. In consequence the guns can continue to fire to the greatest possible degree, and are only prevented from firing, but then automatically, when there is danger of shooting away one of these control surfaces. Adjustment of the guns does not affect the safety switches 44, 45R, and 45L, for the opening of these switches is governed by the position of the corresponding control surface, and not by the position of the guns, yet the guns, whatever may be their position of adjustment, are positively prevented from firing only during such part of their adjustment as directs them toward the fixed horizontal stabilizer 93, or during a time when a movable control surface is swung into the firing zone, beyond positions shielded by the fixed surface ahead of it.

The guns are controlled, as is customary, by a firing key 40 in the main lead 43. A safety switch 46 is likewise provided in this main circuit, as is customary.

The motor 2 is a reversing motor, and is controlled by a switch 20. Both the switch 20 and the firing key 40 and safety switch 46 are arranged conveniently to the forwardly facing pilot. The firing key 40, indeed, may be upon his control stick, as is customary.

The principles of this invention, particularly as to distant control of a gun upon an airplane, as to the coordination of the sighting means with the adjustable gun, and as to prevention of firing of the gun when an aircraft element moves into its line of fire, may be applied equally well to forwardly firing guns, or to airplanes which are other than single-seated planes, where conditions are such as require such distant control means, coordinating means, or fire-interdicting means. However, the principles of this invention are best realized and are most valuable in a single-seated military fighter airplane, for reasons given at the outset, and it has been described and will be claimed as applied to such an airplane, without intending, however, to restrict its use only thereto.

What I claim as my invention is:

1. In combination, in an airplane having control surfaces, a gun mounted thereon, to fire past said control surfaces, means to adjust the gun while in flight, through a field of fire which includes the path of movement of one or more of such control surfaces, controls for operating said control surfaces, controls for firing said gun, controls for adjusting said gun, and means interconnecting said three controls to automatically interdict operation of the gun while the gun's field of fire includes a control surface, in any position of adjustment of the gun or of any such control surface.

2. In combination in an airplane having a fuselage and normal control surfaces, including the elevator and rudder, at its tail end, controls for operating the elevator and the rudder, a gun mounted upon the fuselage to fire rearwardly, means to adjust the gun, in flight, through a field of fire which encompasses the elevator, in all its positions, and which may encompass the rudder in certain of its adjusted positions, controls for firing said gun, and means interengageable between the several controls to automatically interdict firing of the gun while either the elevator or the rudder, in any adjusted position of either the gun or such control surface, lies within the gun's field of fire, but the controls for firing the gun being otherwise operable for firing past the elevator or rudder.

3. In combination, in an airplane having normal elevator and rudder control surfaces, and controls for operating each thereof, a gun mounted upon the fuselage and directed through an angle between the two control surfaces, its field of fire including a swung position of each such surface, controls for firing the gun, and means interengageable between the various controls to automatically interdict firing of the gun whenever one or the other such control surface, or both, are swung into the field of fire, but permitting firing of the gun whenever the control surfaces are both out of the gun's field of fire.

4. In combination, in an airplane having a fixed surface and a swingable control surface at the trailing edge of the fixed surface, a gun mounted upon the airplane and directed to fire past the fixed surface, but including within its field of fire certain swung positions of the swingable control surface, controls for swinging such control surface, controls for firing the gun, and means interengageable between the controls to automatically interdict firing of the gun whenever the swingable control surface lies within its field of fire, but permitting firing of the gun whenever such control surface is outside the gun's field of fire.

5. In combination, in an airplane having a fixed surface and a swingable control surface at the trailing edge of the fixed surface, a gun mounted upon the airplane and directed to fire past the fixed surface, but its field of fire normally including swung positions of the swingable control surface, means to adjust the gun, in flight, through a field of fire which encompasses the fixed surface, controls for so adjusting the gun, controls for swinging the swingable control surface, controls for firing the gun, and means interengageable between the several controls to automatically interdict firing of the gun whenever the gun's field of fire, by reason of adjustment of the gun or swinging of the control surface, includes the fixed or the swingable surface, but permitting firing of the gun whenever such control surfaces are outside the gun's field of fire.

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