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SIGHTING DEVICE FOR FOLLOWING AERIAL TARGETS

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I have filed an application in Germany, August 4, 1934.

This invention relates to a sighting device for following an aerial target and is an improvement in or modification of the device described in the French patent specification 711,365, which is provided with a speed change gear driven by a constant speed motor and with a hand wheel coupled to the sighting device and to a device for adjusting the driven member of the speed change gear relatively to the corresponding driven member, this driven member being coupled to the sighting device.

According to the invention, the speed change gear is operated by an additional speed change gear disposed between the first said gear and the motor, and means are used for setting the adjusting device of the additional speed change gear according to the reciprocal magnitude of the time of flight (t) a projectile fired from near the sighting device requires for hitting the aerial target viewed by means of the sighting device. This construction of the apparatus entails that, in following the target, the adjusting device of the first said speed change gear is set according to the angle of lead, either to the horizontal or to the altitudinal angle of lead, which depends on whether the speed change mechanism rotates the sighting device about a vertical or a horizontal axis.

The time of flight (t), which is a function of the altitudinal angle of impact (γ_T) and the range of impact (E_T), can be calculated by means of any known apparatus answering the purpose. It is convenient, however, to calculate the time of flight (t) by means of a rotatable and displaceable cam body which can be set by two adjusting devices according to the range of impact (E_T) and the altitudinal angle of impact (γ_T), and which is of such shape that operating these adjusting devices according to these magnitudes (E_T and γ_T) entails such an adjustment of a member cooperating with the said cam body as corresponds to the reciprocal magnitude

$$\left(\frac{1}{t}\right)$$

of that time of flight which corresponds to the said two magnitudes. This member is to be coupled to the adjusting device of the additional speed change gear.

The said two magnitudes (E_T and γ_T) can be calculated by means of any known device answering the purpose. As, however, the required altitudinal angle of impact (γ_T) results from the

algebraical addition of the momentary angle of elevation of the target (γ_M) and the momentary adjustment ($\omega\gamma t$) of the adjusting device of the first said speed change gear, it is advisable to find the said angle (γ_T) in the device itself and to influence the corresponding adjusting device of the said cam body according to this angle.

In the accompanying drawing, which illustrates the invention, Figure 1 shows the different magnitudes to be dealt with in using the apparatus according to the invention, and Figure 2 is a schematical top view of an apparatus for finding the altitudinal angle of impact. For the sake of simplicity, it is assumed in the two figures that the aircraft to be followed is moving in a vertical plane through the sighting line.

In Figure 1, A is the place on which the apparatus is mounted, Z is the position an aircraft moving in the direction indicated by the arrow assumes at the moment at which it is viewed, and T is the point of impact which is to be aimed at in order to have the aircraft hit by a projectile shot by a gun at A and having a time of flight t . $AT = E_T$ is the range of impact. AB is a horizontal line through A. The altitudinal angle to be measured is the angle $BAZ = \gamma_M$. The angle of lead ZAT is the product of the angular speed $\omega\gamma$ of the sighting line AZ and the time of flight t of the projectile. The angle BAT, which is equal to the algebraic sum of the angles BAZ and ZAT, is the altitudinal angle of impact. In Figure 1, the angle of lead is assumed to have a positive magnitude.

In Figure 2, 1 is a base plate rotatable about an axis X—X which is at right angles to the plane of the drawing and which is to be adjusted vertical. 2 is a sighting telescope mounted on the base plate 1 and rotatable about an axis Y—Y in a plane at right angles to X—X. The telescope 2 can be rotated about its axis of rotation Y—Y by means of a worm wheel 3, a worm 4 and a shaft 5. On the shaft 5 is mounted the one crown wheel 6 of a differential wheel gear 7. The other crown wheel 8 of this differential wheel gear 7 is disposed on a grooved shaft 9. The corresponding planet wheels 10 and 11 can be rotated about the coinciding axes of the shafts 5 and 9 by means of a hand wheel 12, a shaft 13 and two pairs of bevel wheels 14 and 15. By means of a disengaging coupling 16, the shaft 13 can be coupled to a threaded spindle 17 cooperating with a slide 18 which displaces on the grooved shaft 9 a friction wheel 19 displaceably mounted on this shaft. The friction wheel 19 and a coordinated friction disc 20, which is fixed

to a grooved shaft 21, constitute a speed change gear. On the grooved shaft 21 is displaceably mounted a friction wheel 22 which is coordinated to a friction disc 23 driven at constant speed by means of a motor 24, the wheel 22 and the disc 23 constituting another speed change gear. A slide 25 which has a female thread in mesh with a threaded spindle 26 displaces the friction wheel 22 on the shaft 21. The spindle 26 is rotated by means of a pinion 27 and a rack 28 which is displaceable at right angles to the axis of the spindle 26 and held in continuous contact with a cam body 29 by means of a spring 30. The cam body 29 is displaceable on a grooved shaft 31. A forked arm 33 of a slide 34 is astride on the nave 32 of the cam body 29. This slide 34 has a female thread in mesh with a threaded spindle 35 which is continuously rotated to a position according to the range of impact E_r by members (not represented in the drawing) of the firing director, of which the illustrated apparatus forms part. The range of impact can be obtained for instance by means of an apparatus according to patent specification 2,071,425. To the one end 36 of the shaft 31, which is cranked, is mounted the planet wheel 37 of a differential wheel gear 38 whose one crown wheel 39 is part of a wheel body 40 loosely rotatable about the shaft 31. The wheel body 40 has also a bevel wheel 41 which is in mesh with a bevel wheel 42 fixed to the threaded spindle 17. The other crown wheel 43 of the differential wheel gear 38 is part of a wheel body 44 rotatably mounted on the base plate 1. This wheel body 44 has also a bevel wheel 45 which is in mesh with a bevel wheel 47 fixed to a shaft 46. The shaft 46 is coupled to the shaft 5 by means of a pair of bevel wheels 48, a shaft 49 and a pair of bevel wheels 50.

The cam body 29 is of such shape as to impart to the rack 28 an adjustment according to the reciprocal magnitude of that time of flight t which is the function of the range of impact E_r and the altitudinal angle of impact γ_r for that position of the point of impact as corresponds to the target Z aimed at by the telescope 2. In conformity with the description, the spindle 35 is to be rotated according to E_r , and the cam body 29 is therefore displaced on the grooved shaft 31 according to E_r . At the same time, the shaft 31 and the cam body 29 are to be rotated to a position according to γ_r . This fact clearly appears from the following:

When the telescope is rotated from its horizontal position into a position in which it is inclined relatively to a horizontal line at the angle of elevation of the target γ_m , the crown wheel 43 of the differential wheel gear 38 is also rotated to a position according to this angle by means of the pairs of bevel wheels 50, 48, 47, 45 and the shafts 49, 46. The angular speed of the grooved shaft 9, which effects the automatic drive of the telescope 2 about the altitudinal axis of rotation Y—Y, is proportional to the angular speed ω_γ of the sighting line when the friction wheel 19 is so adjusted relatively to the friction wheel 20 that a rotation by hand of the handwheel 12 can be dispensed with. As the adjustment of the rack 28, and consequently also that of the spindle 26, are in inverse proportion to the time of flight t of the projectile, and as the angular speed of the friction wheel 23 is constant, the angular speed of the friction disc 20 is also inversely proportional to the time of flight t of the projectile. It is necessary in this

case that the distance of the friction wheel 19 from the centre of the friction disc 20 assumes the magnitude $\omega_\gamma t$. To obtain this distance, the spindle 17 is to be rotated by means of the hand wheel 12 according to $\omega_\gamma t$, this rotation being transmitted to the crown wheel 39 of the differential wheel gear 38. The planet wheel 37 imparts to the shaft 31 a rotation which corresponds to the algebraic sum of the rotations of the two crown wheels 43 and 39, viz. to a rotation according to $\gamma_T = \gamma_m \pm \omega_\gamma t$. In Figure 2 it is assumed that γ_T is equal to the difference of γ_m and $\omega_\gamma t$. When in use, the spindle 35 is to be continuously adjusted according to the range of impact E_r and, subsequently to having disengaged the coupling 16, the apparatus is to be so adjusted by rotation about the axis X—X and by rotation of the handwheel 12 that the aerial target to be followed is on the cross wires in the telescope 2. Thereupon the coupling is to be re-engaged. By now rotating the apparatus about the axis X—X and by rotating the handwheel 12, the target is made to remain on the cross wires. Gradually, the mechanical drive by means of the friction wheel gears 22, 23 and 19, 20 is taking charge of the rotation of the telescope about the axis Y—Y and, finally, in the case of a constant angular speed of the sighting line, the rotation of the handwheel 12 can be dispensed with, or, in the case of a variable angular speed of the line of sight, the hand wheel 12 need be given only a small additional rotation. The shaft 31 transmits the sought altitudinal angle of impact γ_T to other parts of the firing director.

I claim:

1. In a sighting device for following an aerial target, a hand wheel for adjusting the sighting device, two speed change gears, each of these gears having a driving member and a driven member, the driven member of each speed change gear being adjustable relatively to the corresponding driving member by means of an adjusting device, a motor of constant speed coupled to the driving member of one of the two speed change gears, means for adjusting the adjusting device of this one speed change gear according to the reciprocal magnitude of the time of flight required by a projectile fired from near the sighting device for hitting the target to which the said sighting device is directed, means for so coupling the driven member of this one speed change gear to the driving member of the other speed change gear as to drive this driving member, means for coupling the driven member of this other speed change gear to the sighting device, and means for coupling the adjusting device of this other speed change gear to the said hand wheel.

2. In a sighting device for following an aerial target, a hand wheel for adjusting the sighting device, two speed change gears, each of these gears having a driving member and a driven member, the driven member of each speed change gear being adjustable relatively to the corresponding driving member by means of an adjusting device, a motor of constant speed coupled to the driving member of one of the two speed change gears, a cam body, means controlled by said cam body for adjusting the adjusting device of this one speed change gear, this cam body being rotatable and displaceable along an axis, means for so coupling the driven member of this one speed change gear to the driving member of the other speed change gear as to drive this driving member, means for coupling the driven member of this other speed change gear to the sight-

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ing device, means for coupling the adjusting device of this other speed change gear to the said hand wheel, means for rotating and means for displacing the said cam body according to the altitudinal angle of impact (γ_T) and to the range of impact (E_T) respectively, the cam body being of such shape that adjusting the cam body according to the said two magnitudes (γ_T and E_T) entails an adjustment of the adjusting device of the said one speed change gear according to the reciprocal magnitude of the time of flight required by a projectile fired from the place of the apparatus for hitting the target to which the sighting device is directed, the said time of flight being a function of the altitudinal angle of impact (γ_T) and of the range of impact (E_T).

3. In a sighting device for following an aerial target, a hand wheel for adjusting the sighting device, two speed change gears, each of these gears having a driving member and a driven member, the driven member of each speed change gear being adjustable relatively to the corresponding driving member by means of an adjusting device, a motor of constant speed coupled to the driving member of one of the two speed change gears, a cam body, means controlled by the cam body for adjusting the adjusting device

of this one speed change gear, this cam body being rotatable and displaceable along an axis, means for so coupling the driven member of this one speed change gear to the driving member of the other speed change gear as to drive this driving member, means for coupling the driven member of this other speed change gear to the sighting device, means for coupling the adjusting device of this other speed change gear to the said hand wheel, means for displacing the said cam body according to the range of impact (E_T), means for so coupling the sighting device and the adjusting device of the said other speed change gear to the said cam body as to rotate the cam body according to the altitudinal angle of impact (γ_T), the cam body being of such shape that adjusting the cam body according to the said two magnitudes (E_T and γ_T) entails an adjustment of the adjusting device of the said one speed change gear according to the reciprocal magnitude of the time of flight required by a projectile fired from near the sighting device for hitting the target to which the sighting device is directed, the said time of flight being a function of the altitudinal angle of impact (γ_T) and of the range of impact (E_T).

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