E. MÜLLER.

ARRANGEMENT FOR AUTOMATICALLY VARYING THE ELEVATION OF A GUN FOR A GIVEN RANGE ACCORDING TO THE HEIGHT OF THE TARGET.

APPLICATION FILED FEB. 16, 1911.

Patented June 15, 1915.

1,143,428.

3 SHEETS—SHEET 1.

Fig. 1.

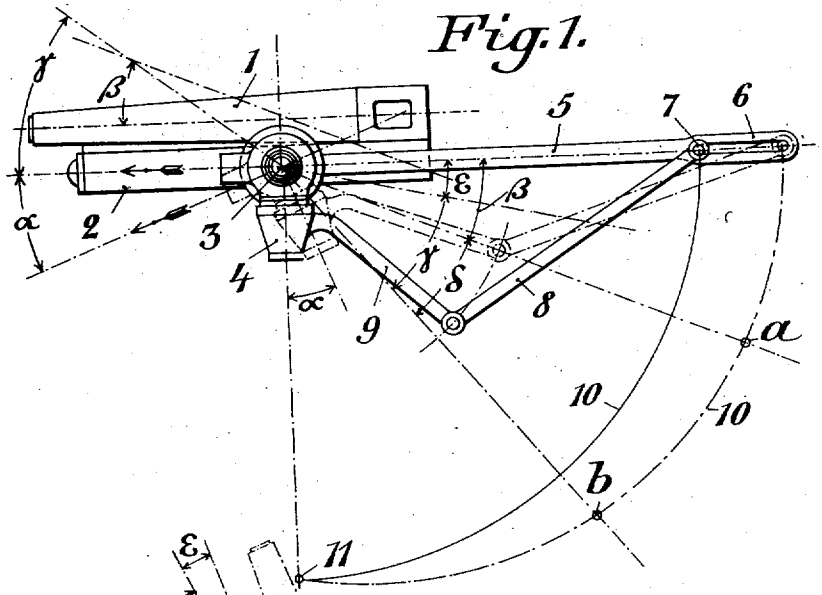

Fig. 2.

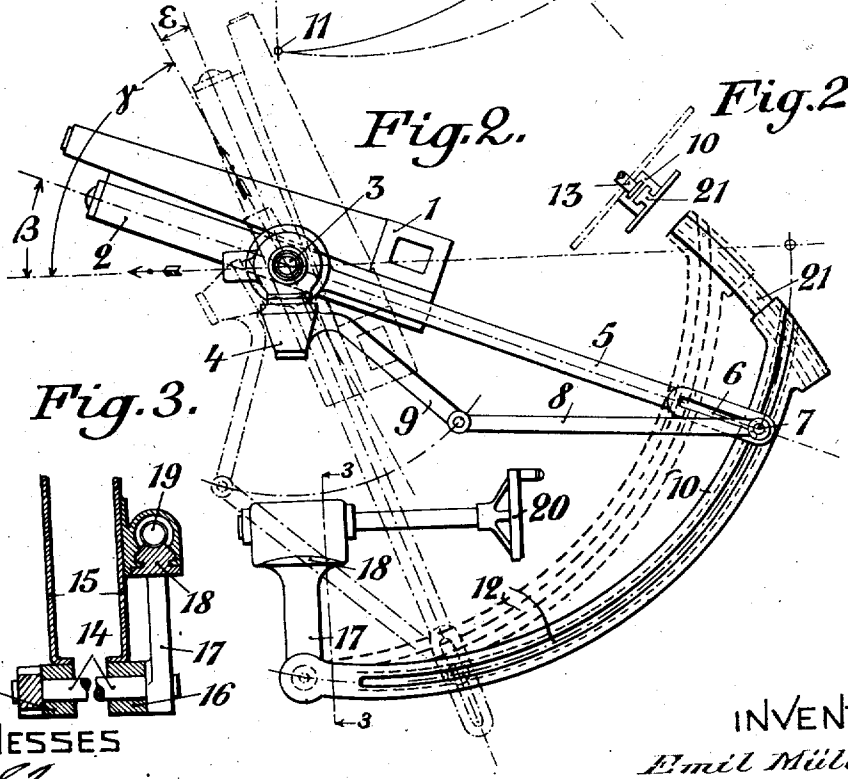

Fig. 2a

Fig. 3.

WITNESSES

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Fig. 4.

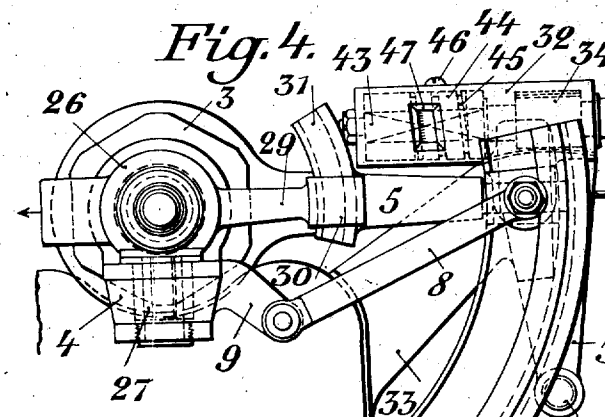


Fig. 6.

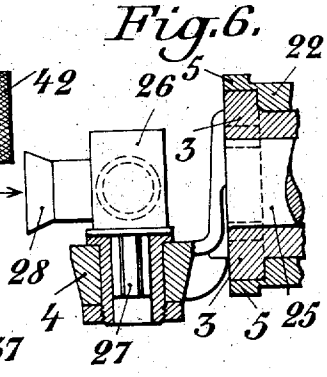


Fig. 8.

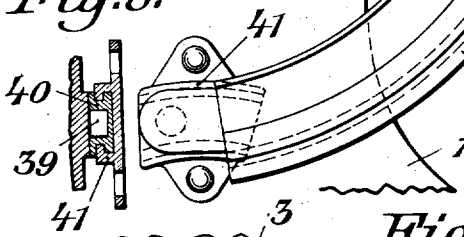


Fig. 7.

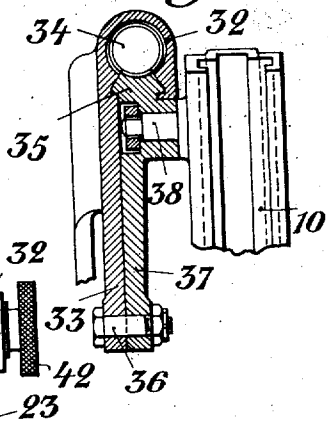


Fig. 5.

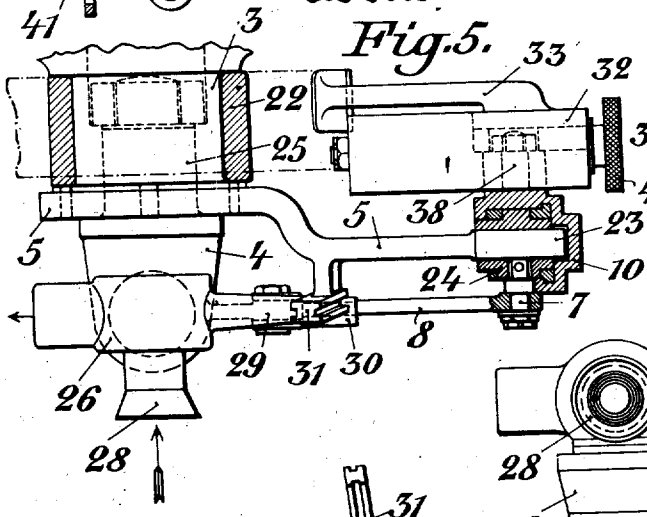


Fig. 10.

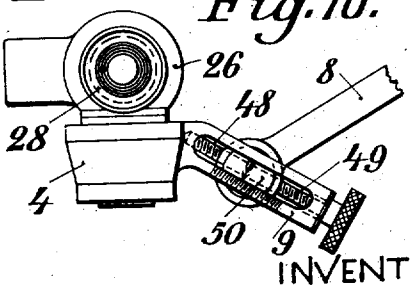
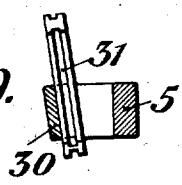


Fig. 9.



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ARRANGEMENT FOR AUTOMATICALLY VARYING THE ELEVATION OF A GUN FOR A GIVEN RANGE ACCORDING TO THE HEIGHT OF THE TARGET.

APPLICATION FILED FEB. 16, 1911.

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3 SHEETS—SHEET 3.

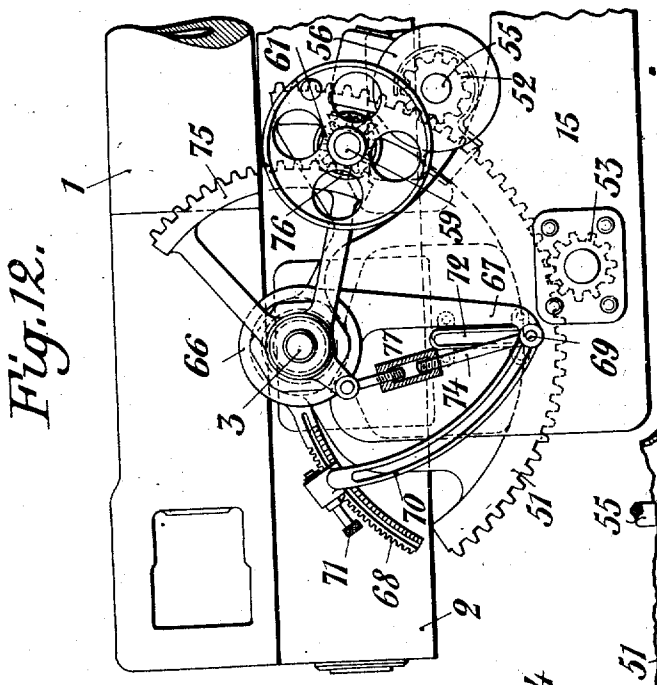

Fig. 12.

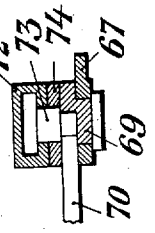

Fig. 14.

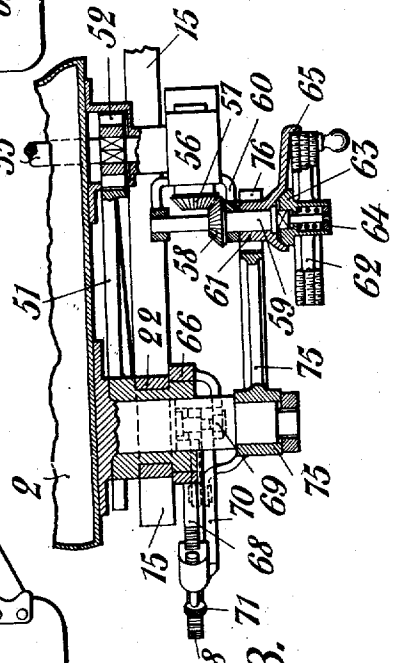

Fig. 13.

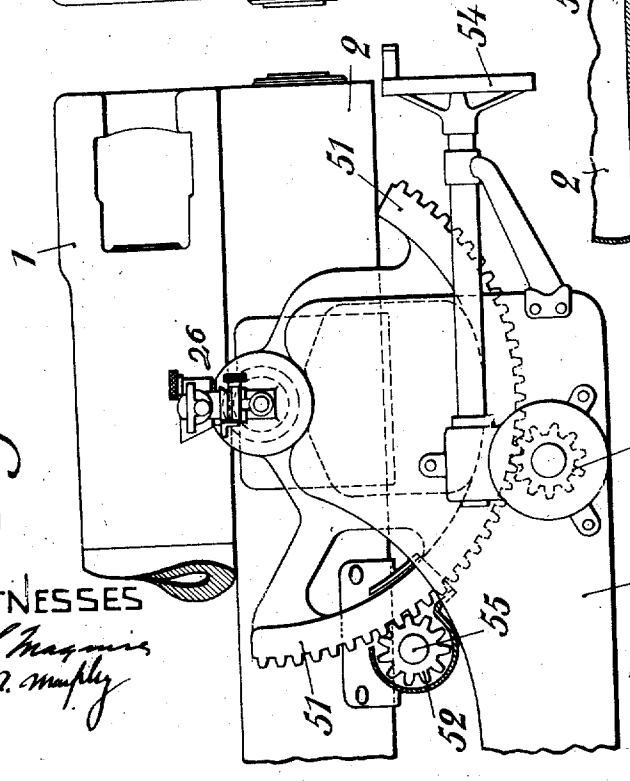

Fig. 11.

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ARRANGEMENT FOR AUTOMATICALLY VARYING THE ELEVATION OF A GUN FOR A GIVEN RANGE ACCORDING TO THE HEIGHT OF THE TARGET.

1,143,428. Specification of Letters Patent. Patented June 15, 1915.

Application filed February 16, 1911. Serial No. 608,915.

To all whom it may concern:

Be it known that I, EMIL MÜLLER, engineer, a subject of the German Emperor, residing at 83 Collenbachstrasse, Dusseldorf, Germany, have invented certain new and useful Improvements in Arrangements for Automatically Varying the Elevation of a Gun for a Given Range According to the Height of the Target; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

It is well known that the angle of elevation of the barrel of a gun for a given range should depend upon the height of the target relative to the gun. This condition is of no importance for ordinary field engagements, since the targets are in or nearly in the horizontal plane of the muzzle of the gun. But this condition has assumed practical importance since it has become necessary to fire at targets which are very much above the gun and subtend a large angle with the horizon, as for example when firing at aerial vessels. In such cases a correction of the range angle according to the altitude of the object is absolutely necessary.

For this purpose arrangements have been proposed, in which when the sight is adjusted on the target, the range angle between the axis of the barrel and the line of sight is automatically changed, so that it corresponds exactly or approximately to the range for which the gun is adjusted, independently of the elevation of the target. In the known arrangements for this purpose the automatic adjustment is brought about by the use of curved surfaces, which do not allow a sufficient accuracy in practical working.

In the present invention an arrangement is employed, by which the curve is in the form of an arc of a circle, which can be constructed with the greatest accuracy in a simple and easy manner. For this purpose in the present invention, when the gun is elevated a pin is positively guided in a curved groove of the carriage, and this pin is connected to the sight carrier and alters the angle between the axis of the barrel and the line of sight according to the shape of the curve.

The invention is illustrated in the drawings which show various examples of construction according to the invention.

Figure 1 shows the whole arrangement diagrammatically; Fig. 2ª is a detailed view of the curved guiding member; Fig. 2 is a practical construction in elevation; Fig. 3 a cross section on line 3—3 Fig. 2; Fig. 4 shows another construction in elevation; Fig. 5 the corresponding plan; Figs. 6–10 corresponding sections through details; Fig. 11 a third construction seen in side elevation from the left hand side of the gun; Fig. 12 the same from the right hand side; Fig. 13 the plan thereof, and Fig. 14 the cross section through a detail.

In all cases a barrel recoil gun is selected by way of example, although the arrangement can be used equally well in rigid or so-called barrel advance guns.

The gun barrel 1 is guided on a cradle 2 and travels along the same during the firing. The cradle is pivoted by means of trunnions 3 in the gun-carriage, which is not shown in the drawings. A sight carrier 4 is pivoted on the left hand trunnion, and on a lateral projection of the same is fixed a usual sighting device consisting of object and eye-glasses or a telescope.

A rearwardly projecting arm 5 is also rigidly fixed to the left hand trunnion, and this arm consequently follows all the movements of the barrel about the axis of the trunnions. At the rear end this arm is provided with a slot 6 running radially to the axis of the trunnion, in which the pin 7 of link 8 engages. The other end of the link 8 is pivoted to a downwardly projecting arm 9 of the sight carrier 4.

A curved piece 10 shown in Fig. 1 simply by a line, is fixed on the carriage. The curved piece 10 can rotate around the point 11 and can be swung out into the dotted position. The end of the link 8 on which the pin 7 is placed engages by means of a sliding block or the like in the curved piece 10, and consequently follows every movement of the latter.

The operation of the described arrange-

ment is as follows:—The curved piece 10 is moved outward through an angle (*e. g.* into the dotted line position) which depends upon the distance from the target, and which can be read off by any known method. This also moves one end of the link 8, the pin 7 sliding along in the slot 6. The link 8 will therefore cause a movement of the arm 9 and the sight carrier 4. The parts will assume the positions shown in dotted lines. The sight carrier 4 and with it the sight resting on it are moved through the angle α from their original position. If the target is in the same horizontal plane as the gun barrel, the barrel must be elevated through the angle β until the telescope is directed on the target. It is particularly to be noted that this angle β need not be equal to the angle α. When the barrel is elevated, the rearwardly projecting arm is also rotated through the angle β, from its original position, so that the pin 7 comes into the position marked *a*. If the target is at an altitude γ, the barrel is still further elevated until the telescope is directed on to the target. While the gun is being raised, the arm 5 forces the pin 7 farther along the curved piece 10, which, according to the distance of the target, is more or less eccentric to the trunnion axis. The pin 7 comes finally into the position marked *b* and during its movement comes nearer and nearer to the trunnion axis. It imparts by means of the link 8 an additional elevating movement to the sight carrier, and itself traverses the arc δ while the sight carrier is elevated through the angle γ. When the line of sight was horizontal the gun had a range angle β, but when the sight is directed at a target at an altitude γ, the range angle between the sight line and the barrel axis has decreased from β to ε, where ε is the range angle for the altitude γ and the range marked on the curved piece. The curved piece 10 is so constructed that for every altitude and for every range marked on the curved piece 10, the necessary range angle is automatically set in the prescribed manner.

In Figs. 2 and 3 a construction is shown which exactly agrees with the diagrammatic representation in Fig. 1, so that what has previously been said also holds good here. The curved piece 10 is in this case provided with an undercut groove in which the enlarged head 13 of pin 7 slides.

The curved piece 10 is rigidly connected to a shaft 14, which is journaled in a bearing 16 fixed to the sides 15 of the carriage. On the side of the carriage turned away from the curved piece, the shaft 14 carries an arm 17, which is provided with a worm segment 18. This is in engagement with a worm 19 on the carriage, which can be rotated by means of the handle 20. On rotating the handle 20 the shaft 14 and with it the curved piece 10 are swung outward. In order to prevent locking, the curved piece 10 is guided at its free end by a curved guide 21 arranged on the gun carriage concentric to the axis of the shaft 14.

The method of operation has already been described with reference to Fig. 1. The full lines show the gun at an elevation or range angle β, which corresponds with a distance *x*. The dotted lines show the position of the parts after the gun has been trained on a target at an altitude γ. In this case the angle β set up between barrel axis and line of sight has automatically decreased to the value ε and this angle ε is the necessary range angle at an altitude γ and range *x*.

The Figs. 4–10 show another construction. Here also there is a rearwardly projecting arm 5 attached to the trunnions 3 which are pivoted in bearings 22. This arm has at its rear end, instead of a slot, a pin 23 (Fig. 5). This pin engages loosely in the socket of a slide block 24. This latter can move to and fro in the guide groove of the curved piece 10 and has a laterally projecting pin 7. To this pin is connected the link 8, the other end of which engages the arm 9 of the sight carrier.

The sight carrier 4 is loosely pivoted by pin 25 in a socket in the trunnion. It carries the sighting telescope 26, which can rotate around a vertical pin 27 (Fig. 6) on the sight carrier. The eye piece is co-axial with the trunnion 3, so that the telescope is used from the side. The telescope 26 carries a rearwardly projecting arm 29 on the outermost end of which a slide block 30 slides along a slide 31 on the arm 5; this slide is curved around the trunnion axis as a center. The arc 31 lies in a plane slightly inclined to the vertical. On a movement of the arms 5 and 29, or, what is the same thing, of the barrel 1 relative to the telescope 26, the telescope 26 is displaced laterally on the sight carrier. The inclination of the arc 31 is such as to compensate the lateral deviation of the shot owing to the rifling of the barrel.

A bearing block 33 provided with a casing 32 is fixed on the upper carriage 15, in which a worm 34 can be rotated. This latter is in engagement with a worm segment 35 of an arm 37 pivoted by means of the bolt 36 to the bearing block 33 (see especially Fig. 7). The curved piece 10 engages the arm 37 by means of a pin 38, so that its upper end follows the movements of the arm 37. A pin 39 fitted in the guide block 40 causes the lower end of the curved piece 10 to follow the movements of the arm 37. This block slides in a circular groove 41 on the carriage 32, and the radius of this groove is such that the two pins 39 and 38 move over arcs of equal curvature. The curved piece 10 is therefore always moved parallel to itself, contrary to the previously described con-

struction, in which it oscillates around a fixed axis.

The movement of the curved piece 10 is effected, as already stated, by the movement of the worm 34, which for this purpose is provided with a hand wheel 42. In order to read the adjustment of the curved piece the worm axis and the cylindrical casing 32 are extended forward. The forward extension 43 of the worm casing is square, and a piston 44 is placed loosely in the bore of the casing and guided so as to be capable of displacement within it; the piston is provided on its periphery with a screw threaded groove 45. In the casing itself there is arranged a screw 46, which engages the screw threaded groove, so that on rotating the worm 34 the piston receives a screw like motion. The piston carries a scale which moves before the window 47 of casing 32 and shows a reading, which can be set according to the range.

Fig. 10 shows a further variation of the above described construction, the drawing showing the connection between the link 8 and arm 9 of the sight carrier 4. A slide block 50, which forms the engaging pin for the link 8, can be moved by means of a screw 49 in a slot 48 of the arm 9. By displacing the slide block 50 it is possible to make a further correction in the range angle, which may be desirable in order to allow, for example, for the speed with which the target approaches or recedes from the gun.

Figs. 11, 12, 13 and 14 show a construction of the invention as applied to a gun in which the adjustment of the altitude and range angles is effected by two completely separate mechanisms.

On each side of the gun barrel 1, toothed segments 51 attached to the cradle 2, are loosely pivoted on the trunnions 3. Two pinions 52 engage in these segments, and can be rotated by a self locking mechanism which will be described later. Besides this, two other pinions 53 journaled to the carriage 15, engage in the segments 51, and can be moved through intermediate worm gear by the hand wheel 54 arranged on the left hand side of the gun. If the wheel 54 is rotated then the segments 51 are swung around the trunnion axis and take with them the cradle 2, barrel 1 and the telescope 26 arranged on the left segment. This mechanism therefore serves to set the sight on the elevated target.

A worm wheel and a worm are in engagement in the casing 56 at the right hand end of the axle 55 of the pinions 52. The worm is on the same axle as a bevel wheel 57 which engages with a bevel wheel 58. The axle 59 of this bevel wheel 58 is journaled in a collar 61 provided in a bearing frame 60. A hand wheel 62, fixed as regards rotation but capable of sliding, is arranged on the free end of the axle 59, and the bevel surface 63 of the hand wheel is pressed by a spring 64 against a corresponding bevel surface of the collar 61, so that normally the collar 61 and axle 59 are coupled together. The hand wheel 62 carries on its periphery a scale to which is set a pointer 65 of the collar according to the range. For the adjustment for the distance, the hand wheel 62 has to be drawn out until the pointer 65 points to the required setting.

On the right hand side of the gun (Fig. 12) a two armed lever 66 is fixed on the toothed segment, the two arms 67 and 68 of the lever forming an acute angle. To the pin 69 at the end of the arm 67 there is linked a slotted curved piece 70 (Figs. 12 and 14) which rests with its other end on the arm 68 which is formed as a circular arc about the center of the pin 69. The arm 68 itself is provided with teeth, which engage with a worm journaled in the curved piece so that the curved piece 70 can be set by rotating the worm by the hand wheel 71. The setting of the curved piece 70 is effected according to the range angle on firing and conforms completely with the adjustment of the curved piece 10 in the earlier figures.

On the carriage 15 is a guide slot 72, in which the pin 73 can move radially to the trunnion axis. This pin 73 engages in the slot of the curved piece 70 and is pushed more or less along the guide 72, when the toothed segment is moved, that is when the altitude is changed, according as the curved piece is set corresponding to the range angle more or less eccentrically to the trunnion axis.

To the pin 73 is connected a draw rod 74 which is linked at the other end to a toothed segment 75 loosely journaled on the trunnion axis, so that a movement of the pin 73 radial to the trunnion axis—any other movement being excluded by the guide 72—causes a rotation of the toothed segment 75. The latter transfers this movement to the collar 61 in engagement therewith through the teeth 76. The collar 61 carries with it the hand wheel 62 and by intermediate gearing moves the pinion so that if the altitude increases the range angle decreases, and vice versa. The range set on the scale on the hand wheel 62 remains at the same value. It can then be easily understood how on setting the altitude the elevation is automatically adjusted.

The draw rod 74 can be adjusted in length by a nut 77 having right and left handed screw threads. In this manner corrections can be made in the angle between the barrel axis and line of sight, which corrections remain independent of the altitude and the range, as already described with reference to Fig. 10.

The arrangement described above may give rise to a small error in the setting, if the tail of the carriage should be higher or lower than the normal position. Such a variation in the position is equally as important as a variation in the altitude. The error, which is very small, can also easily be overcome by suitable means, for example by rotating the curved piece 10 in Fig. 2 around the trunnion axis corresponding to the altered position of the carriage according to the higher or lower position of the tail.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In combination with a pivotally-mounted gun-barrel, and a sighting-device, means forming a sliding connection between the gun-barrel and the sighting-device, a curved member pivoted at one end and to which said sliding connection is slidably connected, and means for moving said member on its pivot whereby as the barrel is raised the angle between the axis of the barrel and the line of sight is altered.

2. In combination with a pivotally-mounted gun-barrel, and a sighting-device, means forming a sliding connection between the gun-barrel and the sighting-device, a curved guiding member pivoted to the gun-carriage at a point vertically below the barrel pivot, at which point all the curves intersect, and means for moving said member to adjust the angle between the axis of the barrel and the line of sight for every elevation of a target at any given range.

3. In combination with a pivotally-mounted gun-barrel, and a sighting-device, a slotted member carried by the gun-carriage, an arm projecting from the sighting-device, a link connected to said arm and adjustably held to said slotted member, and a curved member capable of being moved in a plane parallel to the plane of movement of the gun-barrel and to which said link and slotted member are slidably secured.

In testimony whereof, I have signed this specification in the presence of two subscribing witnesses.

EMIL MÜLLER. [L. S.]

Witnesses:
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ALFRED HENKEL.