W. AKEMANN.

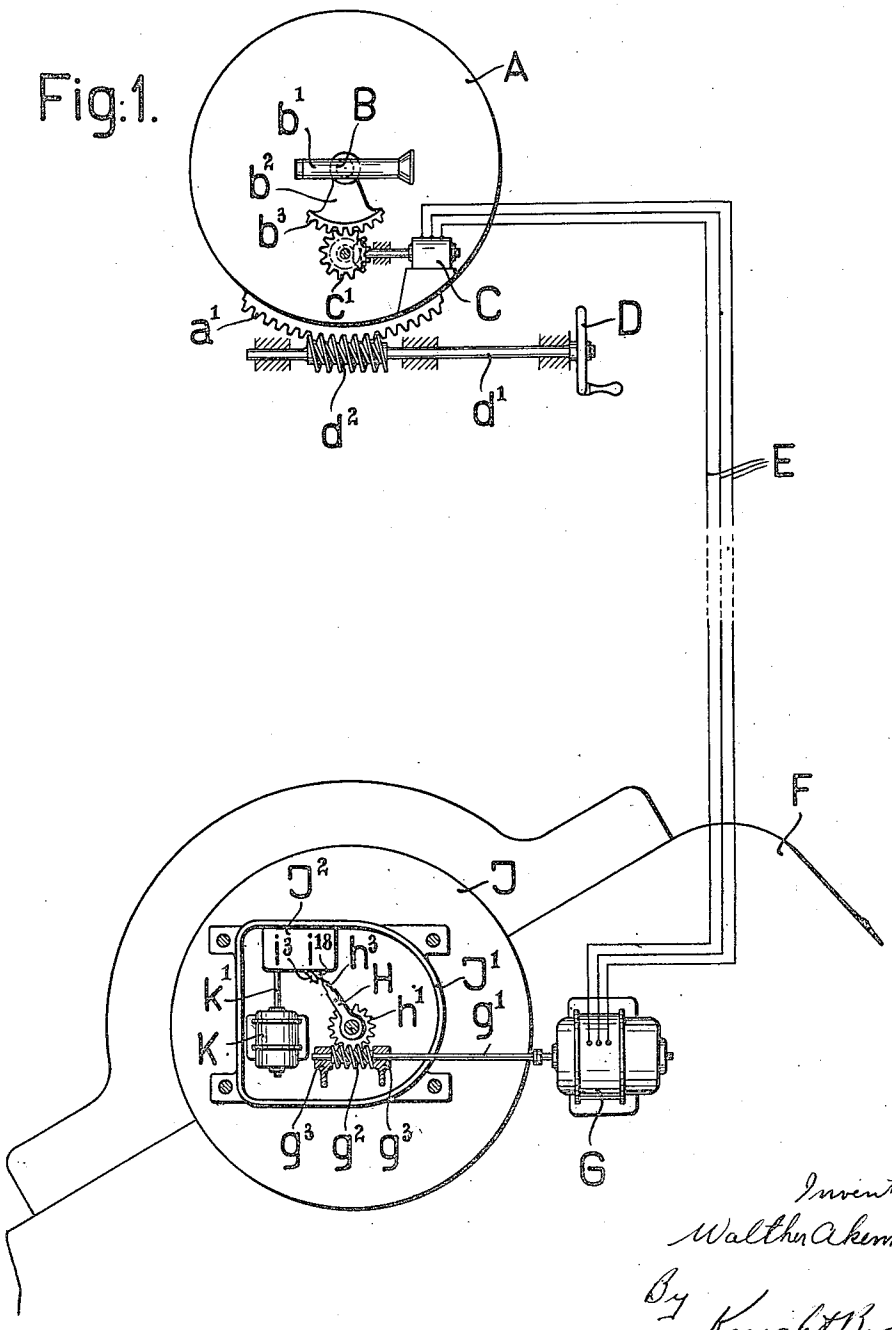
FIRE CONTROL APPARATUS PARTICULARLY INTENDED FOR NAVAL GUNS.

APPLICATION FILED SEPT. 3, 1920.

1,387,440. Patented Aug. 9, 1921.

3 SHEETS—SHEET 1.

Fig. 1.



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3 SHEETS—SHEET 2.

Fig.2.

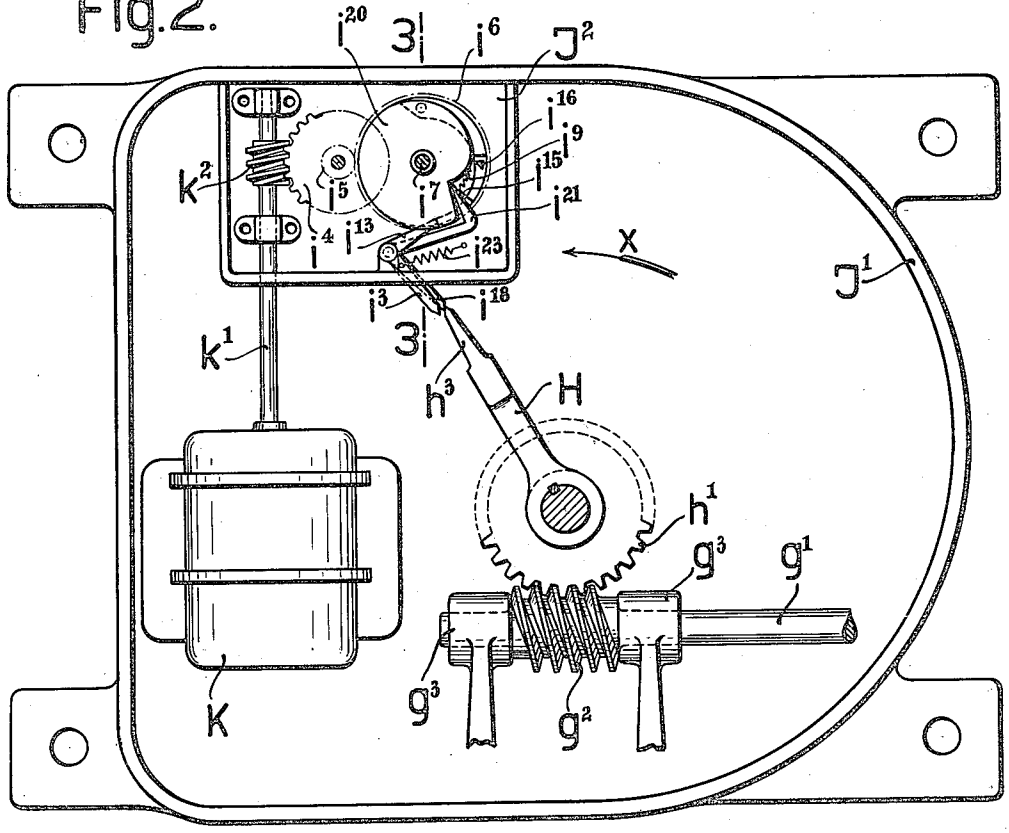


Fig.3.

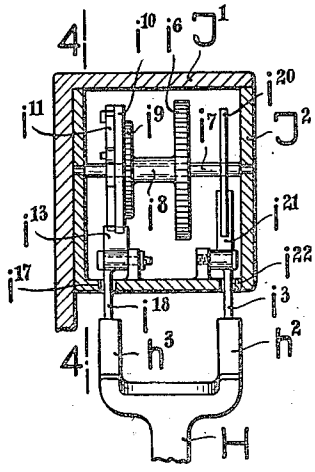
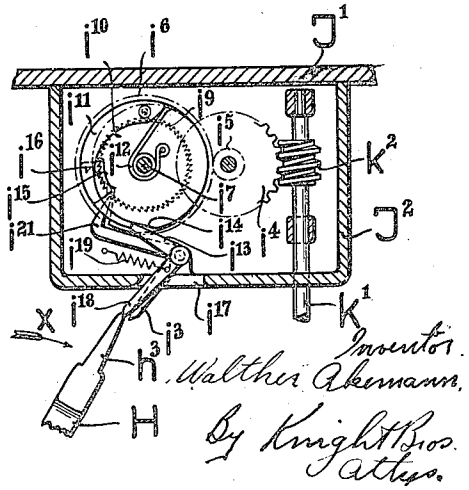


Fig.4.



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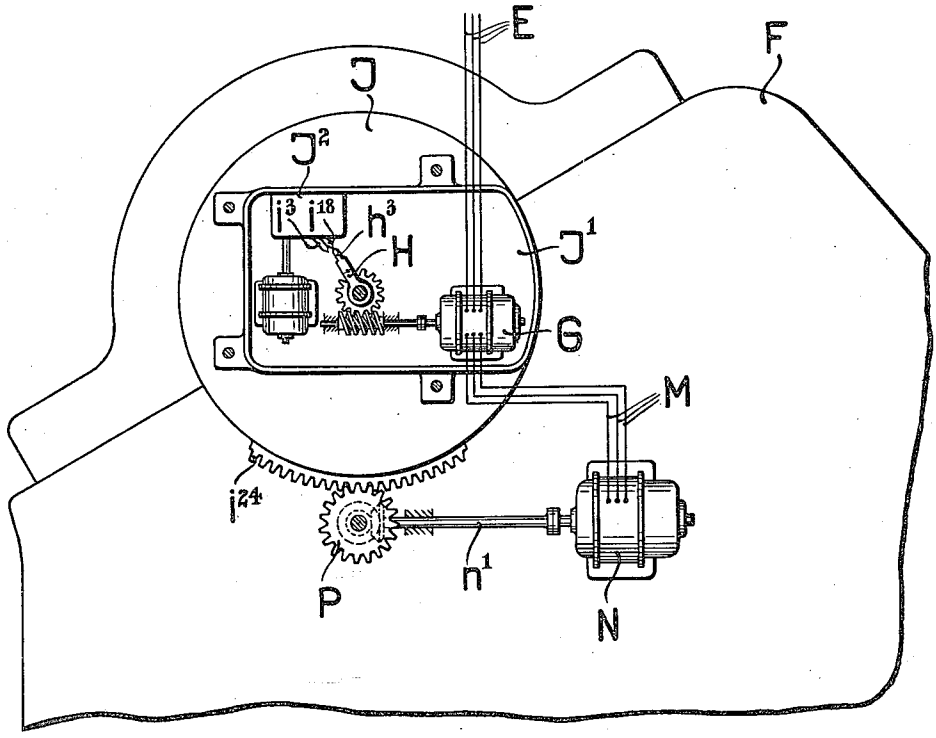
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3 SHEETS—SHEET 3.

Fig.5.



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UNITED STATES PATENT OFFICE.

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FIRE-CONTROL APPARATUS PARTICULARLY INTENDED FOR NAVAL GUNS.

1,387,440. Specification of Letters Patent. Patented Aug. 9, 1921.

Application filed September 3, 1920. Serial No. 408,072.

To all whom it may concern:

Be it known that I, WALTHER AKEMANN, residing at Essen, Germany, a citizen of the German Republic, have invented a certain new and useful Improvement in Fire-Control Apparatus Particularly Intended for Naval Guns, for which I have filed application in Germany, filed June 26, 1917, of which the following is a specification.

This invention relates to a fire control apparatus which is particularly intended for naval guns, and in which one part of the adjustable parts, corresponding to the advanced ignition, of an apparatus for effecting the laying of the gun, is so connected by means of a long distance controlling apparatus to a stabilizable sighting instrument placed at the observing station that it accurately reproduces the movements of the sighting instrument as regards angle, while the other part is mounted on a member which takes part in the adjusting movement of the gun barrel.

The invention will be described with reference to the accompanying drawing which illlustrates diagrammatically two constructions intended for naval guns.

Figure 1 shows the first construction.

Fig. 2 shows a portion of Fig. 1 drawn to an enlarged scale.

Fig. 3 is a section on the line 3—3 of Fig. 2 looking from the left,

Fig. 4 is a section on the line 4—4 of Fig. 3, looking from the left and

Fig. 5 shows to the same scale as Fig. 1 a second construction with the parts which are situated at the observing station omitted.

In the construction shown in Figs. 1 to 4, A denotes a gyroscope casing which is set up at the observing station and cam oscillate about a horizontal axis B, which coincides with the axis of oscillation of the gun barrel and can be stabilized by the gyroscope (not shown) suspended by means of a Cardan suspension, b^1 is a sighting telescope rigidly attached to the axis B and on this axis B is also rigidly mounted a toothed sector b^2 which is connected by toothed wheel gearing b^3, c^1, to the rotating part of a transmitter C of an electrical long distance controlling apparatus mounted on the casing A of the gyroscope.

The casing A is rocked about its horizontal axis by a hand wheel D, on the shaft d^1 and said shaft d^1 is mounted on the base of the casing of the gyroscope, and carries a worm d^2 which coöperates with a series of teeth a^1 on the casing A.

The transmitter C is electrically connected by a long distance conductor E with a receiver G mounted on the gun carriage F, of the gun to be fired. Upon the shaft g^1 of the receiver G, turning in bearings g^3 fixed to the gun carriage F, is mounted a worm g^2, which gears with a worm wheel h^1. This worm wheel h^1 is mounted to rotate loosely on the trunnion J, about the axis of the trunnion. Upon the worm wheel h^1 is rigidly mounted an arm H forked at its free end (see Fig. 3) and one of the forked ends is constructed in the form of a tongue-shaped circuit-closing piece h^2 and the other has a tongue-shaped stop h^3, both ends lying in the same axial plane. The general arrangement of the long distance controlling apparatus C, E, G, which transmits the rotary movement of the sighting telescope b^1 to the arm H is such, that every rotary movement of the sighting telescope b^1 with respect to the casing A results in a similar rotary movement of the arm H. On the front of the trunnion J is rigidly fixed a box J^1 which contains in its interior in addition to the parts already mentioned namely g^2, g^3, and h^1, H, h^2, h^3, a small casing J^2 and a motor K. This motor K is for the purpose of adjusting, by means of a pinion gear within the casing J^2 (see Figs. 2 to 4), a circuit-closing piece i^3 coöperating with the circuit-closing piece h^2, to correspond to the preliminary ignition angle which is necessary. The circuit-closing pieces h^2 and i^3 are included in a circuit which contains the firing magnet (not shown) of the gun and forms a circuit-closing apparatus, by the closing of which the operation of firing can be accomplished. The box J^1 is closed at the front by a cover (not shown in the drawing), in which is inserted a piece of glass for observing the arm H and the part of the pinion gear which coöperates therewith inclosed in the casing J^2.

The pinion gear inclosed in the casing J^2 is shown on a larger scale in Figs. 2 to 4. A worm k^2 mounted on the shaft k^1 of the motor K is carried in bearings in the casing J^2 and gears with a worm wheel i^4, which by means of intermediate gearing i^5 i^6 drives a hollow shaft i^8 (see Fig. 3) which is adapted to rotate freely on a shaft i^7 carried in

bearings in the casing J^2. To the hollow shaft i^8 is rigidly attached a toothed ratchet wheel i^9. On a circular-shaped disk i^{10} keyed close up against the ratchet wheel i^9 is pivotally mounted a pawl i^{11} which bears against a pawl i^{13} mounted on the casing J^2. This pawl i^{13} (see particularly Fig. 3) is wider than the pawl i^{11} and bears when in the position shown in the drawing, against a recess i^{14} in the disk i^{10} (see Fig. 4). The disk i^{10} has a gap in it, i^{15}, through which a tooth i^{16} fixed on the pawl i^{11} projects. When the pawl i^{13} emerges from the recess i^{14} in the disk i^{10} and releases the pawl i^{11}, this tooth can engage under the action of the spring i^{12} (see Fig. 4) with the ratchet wheel i^9 and thereby couple the hollow shaft i^8 to the shaft i^7. The release of the pawl i^{11} is effected by a tongue i^{18} which projects through a slot i^{17} in the casing J^2 and is rigidly connected to the pivot pin of the pawl i^{13}. The point of this tongue i^{18} protrudes in to the path of the tongue-shaped stop h^3 fixed on the arm H so that the stop h^3 can bear against the tongue i^{18} and when the stop h^3 moves in the direction of the arrow x (see Figs. 2 and 4) can carry the tongue i^{18} a short distance against the action of a spring i^{19} attached to the tongue i^{18}. On the shaft i^7 in addition to the disk i^{10} is also keyed a disk cam i^{20}, against the spirally curved external surface of which, a hook-shaped lever arm i^{21}, of a bell crank lever pivotally mounted in the casing J^2 bears, and the other arm of which is formed by the circuit-closing piece i^3. This circuit-closing piece i^3 projects through a slot i^{22} in the casing J^2 and a tension spring i^{23} attached to the circuit-closing piece i^3 tends to permanently press the point of the lever arm i^{21} against the edge of the disk cam i^{20}. The length of the circuit-closing piece i^3 is so calculated that its point projects into the path of the circuit-closing piece h^2 on the arm H, so that the two circuit-closing pieces i^3 and h^2 can in passing, say, during the upward rolling of the ship, touch each other. The tongue i^{18} and the circuit-closing piece i^3 inclose, in the position shown in the drawing, in which the pawl i^{13} bears against the recess i^{14} and the hook-shaped lever arm i^{21} lies on the lowest point of the disk cam i^{20}, a small angle with each other, so that on a rotary movement of the arm H, in the direction of the arrow x the tongue i^{18} must be touched by the stop h^3 a little sooner than the circuit-closing piece h^2 can come into contact with the circuit-closing piece i^3.

In order that the working of the above described fire control apparatus may be readily understood it will be first assumed that the ship has taken its middle floating position and does not make any rolling movements and that the parts of the apparatus are in the position shown in the drawings.

If for example the gun is to be laid to correspond to the range of the target by means of the above described fire control apparatus and fired, the sighting telescope b^1 is adjusted to the target to be fired at, with the gyroscope in action, and maintained in this position, by suitable lateral pressure on one Cardan ring of the gyroscope apparatus, in a manner similar to that described in my co-pending application, Serial No. 408,090. The gyroscope casing A is next rocked by rotating the hand wheel D through the angle corresponding to the range of the target. As the sighting telescope b^1 does not alter its position owing to the action of the gyroscope, the toothed wheel c^1 rolls during this rocking movement over the teeth b^3 and rotates the adjustable part of the transmitter C through an angle which is approximately equal to the angle of elevation. This rotation is repeated through the medium of the receiver G, connected to the transmitter C, by the circuit-closing piece h^2 and stop h^3 mounted on the arm H connected to the said receiver G, in such a manner that they are rotated through a similar angle out of their original angular position. The gun barrel laterally laid upon the target is next rocked about the axis of the trunnions by the elevating gear until the tongue i^{18} which is mounted on the axis of the trunnions and therefore takes part in the rocking movement of the gun barrel is again opposite the stop h^3. As soon as this is the case the tongue i^{18} and the gun barrel have been rotated through an angle corresponding to the range of the target out of their original angular position. The gun barrel therefore assumes an elevation corresponding to the range of the target in respect of the ship in its horizontal floating position and the firing of the gun takes place in this case by hand.

If on the other hand the ship rolls and the firing of the gun is to be effected automatically as the ship passes through the middle floating position at an instant, which lies by a period of time equal to the delay in firing, in advance of the instant in which the ship passes through its middle floating position, it is necessary to adjust the two circuit-closing pieces h^2 and i^3 with respect to each other through a preliminary ignition angle corresponding to the delay in firing. For this purpose the motor K is set in motion and kept at a constant number of revolutions. The hollow shaft i^8 connected to the motor K by the intermediate gears k^2, i^4, i^5, i^6, consequently together with the ratchet wheel i^9 rotate with a uniform velocity.

When therefore by the rotation of the arm H in the direction of the arrow x, the stop h^3 on the arm H bears against the tongue i^{18}, the pawl i^{13} leaves the recess i^{14} in the disk i^{10} and consequently releases the pawl i^{11}.

This latter bears, under the action of the spring i^{12}, with its tooth i^{16} against the ratchet wheel i^9. By this means the coupling between the hollow shaft i^8 connected to the ratchet wheel i^9 and the shaft i^7 which carries the disk i^{10} and the disk cam i^{20} is established. By this means the rotary motion of the motor shaft k^1 is transmitted to the shaft i^7. On the rotation of the disk cam i^{20} which now commences, the hook-shaped lever arm i^{21} slides on the edge of the disk cam, and this results in a displacement of the circuit-closing piece i^3 in such a direction that the said circuit-closing piece i^3 moves out of the way of the circuit-closing piece h^2 as this latter moves in the direction of the arrow x. The curvature of the disk cam i^{20} is so designed geometrically that on the rotation of the said cam, the circuit-closing piece i^3 at first moves rapidly and then more and more slowly through such an angular amount that the circuit-closing piece h^2 which follows it with an approximately equal movement touches it in a position which lies by the amount of the desired preliminary ignition angle in advance of the point in which the gun barrel assumes the before described elevation relatively to a horizontal plane. At the instant of contact of the circuit-closing piece i^3 and h^2, the firing circuit is closed, the shot is fired and the projectile leaves the barrel exactly at the instant in which the said barrel assumes the before described elevation angle in respect to a horizontal plane. On the further movement of the arm H the circuit-closing piece h^2 and the stop h^3, comes out of the path of the circuit-closing piece i^3 and the tongue i^{18}, so that these parts can return under the influence of the tension springs i^{23} and i^{19} into the position shown in Fig. 2, as soon as the shaft with the disks i^{10} and i^{20} has made one complete revolution when the pawl i^{13} will again bear on the recess i^{14} and against the pawl i^{11}, thus disconnecting the shaft i^7 from the hollow shaft i^8, so that the shaft i^7 remains stationary.

In order to prevent the circuit-closing piece h^2 and the stop h^3 from coming into contact with the circuit-closing piece i^3 and the tongue i^{18} when the arm H is rotated in a direction opposite to that indicated by the arrow x, means are provided by a movable arrangement (not shown) of the circuit-closing piece and the stop and an electro-magnetic device (likewise not shown) on the arm H which will insure that the circuit-closing piece h^2 and stop h^3 can only assume the position shown in the drawing, when the arm H moves in the direction of the arrow x.

Instead of being fired when the ship passes through the middle floating position the gun can be fired during the course of the rolling movement of the ship by the aid of the above described fire control apparatus, also at an instant in which the gun barrel has been adjusted by the rolling movement of the ship to the elevation angle in respect of a horizontal plane which corresponds to the range of the target. In this case the adjustment of the sighting telescope and of the casing of the gyroscope takes place exactly as has been already described, and the stop h^3 accordingly assumes, an angular position which is shifted by the angle of elevation with respect to its original adjustment. As the stop h^3 retains this position during the further course of the rolling movement of the ship and its corresponding tongue i^{18} together with the gun barrel takes part in the said rolling movement, there is a relative movement between the stop and the tongue. When in the course of this relative movement the stop h^3 and the tongue i^{18} touch each other and the gun barrel has received through the rolling movement an elevation equal to the angle of elevation, the pinion gear inclosed in the casing J^2 is set in motion (as has already been described) and the shot automatically fired in the manner stated.

If the angle of roll of the ship is somewhat less than the necessary angle of elevation of the gun barrel, it is necessary in the last mentioned adjusting operation to impart to the gun barrel by the elevating-gear, an elevation which is at least equal to the difference between the two angles.

The principal advantages of the fire control apparatus herein described are that the entire apparatus is simple and insures an accurate adjustment and that in particular the parts of the fire control apparatus provided on the gun mounting have in addition to the simple construction all the advantages of a gyroscopic firing apparatus, without a separate gun layer being necessary for its operation. Moreover the whole apparatus besides being simple, insures accurate adjustment results, from the fact that the member carried on the gun mounting which indicates the desired elevation to be given to the gun barrel (*i. e.* the circuit-closing piece h^2) is adjustable directly by a gyroscopic sighting apparatus suitable for marking the target and coöperates with a member (*e. g.* the circuit-closing piece i^3) which takes part in the elevating movements of the gun barrel and is adjustable to the preliminary angle of ignition at the time.

The advantages explained are particularly obvious, if—as frequently happens in reality—a number of guns are connected to a single gyroscopic sighting device placed at the observing station.

The construction shown in Fig. 5 differs from the one described, by the fact that the receiver G instead of being mounted on the gun carriage F is mounted inside the box J^1

fixed on the trunnion J and is provided with two field windings (not shown) of which one is connected by the long distance conductor E to the transmitter C (see Fig. 1) and the other by a conductor M to an auxiliary transmitter N, which in its turn is mounted on the gun carriage F. The shaft n^1 of this auxiliary transmitter is connected through a bevel wheel gearing with a spur wheel P which gears into a ring of teeth i^{24} on the trunnion J. The electrical connection between the auxiliary transmitter N and the receiver G is such that a rotation of the trunnion J is corresponded to by an equally great but oppositely directed rotation of the arm H carrying the stop h^3 and the circuit-closing piece h^2.

If during the elevation movement of the gun barrel the trunnion J executes a rotation relatively to the gun carriage F, the arm H then takes part in the rotation of the trunnion. At the same time the auxiliary transmitter N, owing to its connection with the trunnion J, is displaced by an angle which is approximately equal to the angle of rotation of the trunnion. Under the assumption, that the transmitter C remains at rest at the same time, the rotating part of the receiver G mounted on the trunnion J adjusts itself in such a manner that the arm H is given a rotation equal to the angle of rotation of the trunnions, but in the opposite direction and consequently retains its position relatively to the gun carriage F. If now a moving force say by the adjustment of the transmitter C (see Fig. 1) acts on the receiver G in addition to the one transmitted from the auxiliary transmitter N, the arm H assumes relatively to the gun carriage F that position which corresponds to the adjustment of the transmitter C and consequently of the sighting telescope b^1. The coöperation of the stop h^3 and of the circuit-closing piece h^2 with the tongue i^{18} and the circuit-closing piece i^3 takes place correspondingly accurately as in the construction first described.

Of course it would be possible, without departing from the invention, instead of providing the receiver G with two field windings, one of which is supplied by the transmitter C and the other by the auxiliary transmitter N, as in the last described construction to employ one receiver, which, as shown in Fig. 1, is merely electrically connected to the transmitter C, but at the same time is mounted on the trunnion J as is shown in Fig. 5. In this case it is only necessary, to interpose between the receiver G and the arm H a sun and planet gear, one wheel of which is connected to a toothed wheel which can roll over a toothed sector rigidly connected to the gun carriage F. In such case by a suitable selection of the ratios of transmission it would also be insured that on rotation of the trunnion J the position of the arm H with respect to the gun carriage F remains the same.

The above described arrangement of the receiver G on the trunnion J instead of on the gun carriage F affords the advantage that the accuracy and reliability of the adjustment of the arm H is not prejudicially affected by the clearance which may exist between the trunnion and the gun carriage. In addition, this arrangement enables the receiver G to be brought, together with the circuit-closing pieces h^2, i^3, within the casing J^1 fixed on the trunnion.

Claims.

1. An apparatus of the class described which comprises a sighting device, means for stabilizing said sighting device, an indicator mounted adjacent the trunnion of a gun, electrical means operatively connecting the sighting device to the indicator, a circuit closing piece carried by said indicator, a second indicator coöperating with the first mentioned indicator, and operatively connected so as to take part in the elevating movement of the gun barrel, said second indicator embodying means which cooperate with the first mentioned indicator and circuit-closing piece, substantially as and for the purpose set forth.

2. An apparatus of the class described which comprises a sighting device, means for stabilizing said sighting device, an arm arranged adjacent a gun, an electrical transmission operatively connecting the sighting device to the arm, said arm being provided with a stop and circuit closing piece, means operatively connected to and taking part in the elevation of the gun said means cooperating with said stop and circuit closing piece for automatically adjusting the advanced ignition apparatus.

3. An apparatus of the class described which comprises a sighting device, a gyroscopic apparatus for stabilizing said device, an indicator, electric transmission means operatively connecting the sighting device to the indicator, and including a receiver, a casing mounted upon a trunnion of the gun, a circuit closing device carried by said indicator, a second indicator coöperating with said first mentioned indicator, said second indicator being operatively connected to the gun trunnion to take part in its rotary movement, additional means contained in said casing and operatively connected to said second indicator for automatically adjusting the advanced ignition apparatus, said additional means coöperating with said circuit closing device for closing an ignition circuit, said receiver being mounted upon the gun carriage.

4. An apparatus of the class described which comprises a sighting device, means for stabilizing said sighting device, an indicator, a circuit closing piece carried by said

indicator, an electric long distance transmission including a transmitter and receiver for operatively connecting the sighting device to the indicator, a casing mounted on the gun trunnion and containing said receiver, a coöperating pointer in said casing, an automatic firing delay apparatus in said casing operatively connected to said pointer, means mounted on the gun carriage for retaining said indicator in the angular position prescribed by the adjustment of the sighting device, said circuit closing piece and automatic firing delay apparatus coöperating to close a firing circuit.

5. An apparatus of the class described comprising a sighting device, a gyroscopic apparatus for stabilizing said sighting device, an indicator comprising a stop and a circuit closing piece, electric transmission means operatively connecting the sighting device to said indicator, indicating means coöperating with said first mentioned indicator, said second indicator being operatively connected to the gun trunnion to take part in its rotary movement, said second indicator embodying a circuit closing piece, a tongue and an advanced ignition apparatus the circuit closing piece of said first and second indicators coöperating to close a firing circuit.

6. An apparatus of the class described comprising a sighting device, a gyroscopic apparatus for stabilizing said device, an indicator having a stop and a circuit closing piece, electric transmission means operatively connecting the sighting device to the indicator and including a receiver, a second indicator coöperating with said first indicator, said second indicator being operatively connected to the gun trunnion to take part in its rotary movement, a casing containing said indicators, said second indicator being provided with a tongue, a circuit closing piece, and an advanced ignition apparatus coöperating therewith, the contact piece of said first and second indicators during the coöperative movement of the indicators being adapted to contact to close an electrical firing circuit.

7. An apparatus of the class described comprising a sighting device, means for stabilizing said sighting device, an indicator mounted adjacent to the trunnion of a gun, means for operatively connected said indicator to said sighting device, a contact and a stop carried by said indicator, a second contact coöperating with the first-mentioned contact and a second stop coöperating with said first-mentioned stop, said second contact and stop being operatively connected to the gun trunnion to take part in its rotary movement, a casing mounted to take part in the rotary movement of the gun trunnion, a ratchet gear and a cam in said casing, an automatic clutch for coupling said cam to said ratchet gear in the moment of coöperation of the two stops and means for driving one part of said clutch with a constant speed.

The foregoing specification signed at Essen, Germany, this 16th day of June, 1920.

DR. WALTHER AKEMANN.

In presence of—
HANS GOTTSMANN,
JOHANN A. DECKERS.