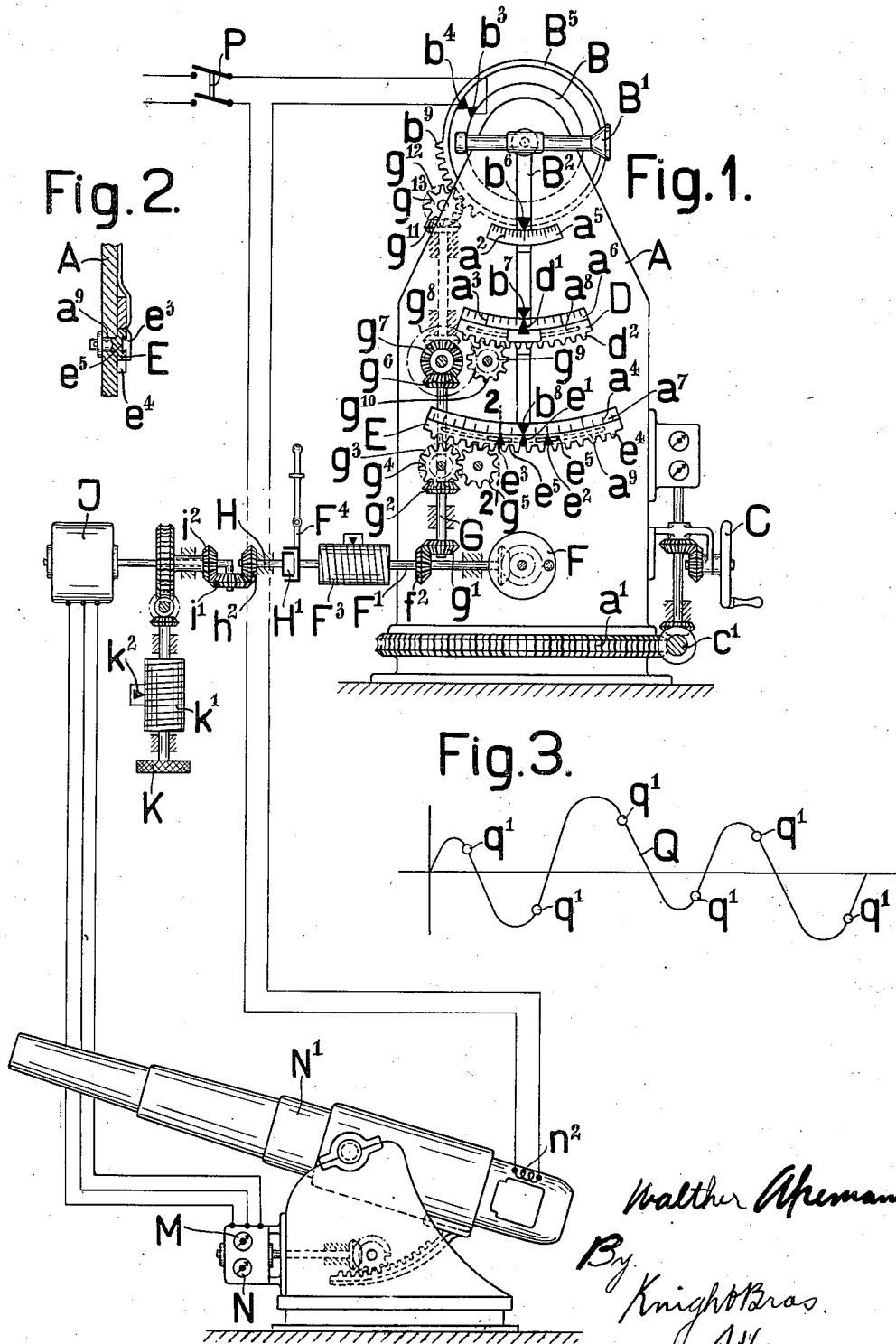


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2 SHEETS—SHEET 1.



Walther Ahermann
By Knight Bros.
Attys

1,384,005.

2 SHEETS—SHEET 2.



Inventor
Walther Akemann,
By Knight Bros.
Attys.

UNITED STATES PATENT OFFICE.

WALTHER AKEMANN, OF ESSEN, GERMANY. ASSIGNOR TO FRIED. KRUPP AKTIEN-GESELLSCHAFT, OF ESSEN-ON-THE-RUHR, GERMANY.

FIRE-DIRECTION APPARATUS FOR NAVAL GUNS.

1,384,005.

Specification of Letters Patent.

Patented July 5, 1921.

Application filed October 23, 1920. Serial No. 419,127.

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-Direction Apparatus for Naval Guns, for which I have filed application in Germany, filed November 4, 1916, of which the following is a specification.

This invention relates to fire control apparatus for naval guns, in which a gyroscopic apparatus is provided which enables the influence of the rolling movements of the ship on the angle of elevation of the gun corresponding to the range of the target to be allowed for.

The object of the invention is to provide an apparatus of the above type which primarily enables the shot to be fired at the point of reversal or in the vicinity of the point of reversal of such rolling movement.

The invention will be described with reference to the accompanying drawing in which Figure 1 diagrammatically shows an example of the construction of the object of the invention, in which the gyroscopic apparatus is placed at an elevated observing station remote from the gun station. Fig. 2 is a section on line 2—2 of Fig. 1. Fig. 3 shows a graphic representation hereinafter referred to and based upon a rectangular system of coördinates, which illustrate a frequently occurring species of irregular rolling movements of a ship and also the instants of firing the shots, and Fig. 4 diagrammatically shows another example of construction of the invention.

The fire control apparatus consists of two apparatuses separated a distance from each other and connected by electrical conductors, one of these two apparatuses being placed at an elevated observing station remote from the gun station and the other at the gun station itself. The apparatus placed at the observing station consists of a casing A which can be rotated about a vertical axis by means of a hand wheel C and a worm gearing c' , a' and in the upper part of which an electrically driven gyroscope B is hung by means of a Cardan suspension. The outer Cardan ring, the pin of which passes through the casing, carries rigidly connected to it a horizontal sighting telescope B', a downwardly extending pointer B² and a firing tongue b^3 . The firing tongue b^4 co-

acting with the firing tongue b^3 is placed on the outer casing B⁵ which surrounds the outer Cardan ring and can be rocked on the casing A about the axis of rotation of the outer Cardan ring by means of a gearing to be hereinafter described. The pointer B² is provided with three marks b^6 , b^7 and b^8 which lie in a straight line and each of which points to a rolling angle scale a^2 , a^3 and a^4 , inscribed on three segmental pieces a^5 , a^6 and a^7 mounted on the casing A and curved concentrically with the axis of rotation of the pointer.

On the casing A are also mounted to oscillate in guides a^8 and a^9 two other segmental pieces D and E which embrace the segmental pieces a^6 and a^7 and include the same angle and of which the upper one has a mark d' placed in the middle of the segment while the lower one is provided with a mark e' likewise placed in the middle and two other marks e^2 and e^3 arranged at equal distances apart on either side of the mark e' . The marks e^2 and e^3 are adjustable in dove-tail guideways e^5 in the bow pieces E (see particularly Fig. 2). The mutual distance apart of the marks e' and e^2 and also e' and e^3 is arbitrarily chosen and depends upon the time by which the instant of firing is to be separated from the instant of reversal of the rolling movement of the ship. The marks e' , e^2 and e^3 and also the mark d' are intended to be brought into register, in a manner to be hereinafter described with the marks b^7 and b^8 on the pointer B², when the rolling movement of the ship takes place and at the same time the relative movements of the pointer B² with respect to the casing A ensue, by correspondingly swinging the segmental pieces D and E outward.

These segmental pieces D and E are swung outward by a hand wheel F mounted on the casing A which transmits its rotation to a horizontal shaft F' and from this latter through a bevel wheel gearing f^2 , g' to a vertical shaft G also mounted on the casing A and positively connected to the segmental pieces E and D and the part B⁵ which carries the firing tongue b^4 by the toothed gearing g^2 , g^3 , g^4 , g^5 , e^4 , g^6 , g^7 , g^8 , g^9 , g^{10} , d^2 and g^{11} , g^{12} , g^{13} , b^5 in the manner shown in the drawing.

The ratios of transmission of the gearings which lead to the segmental piece E and also to the part B⁵ which carries the firing tongue

b^4 , are equal to each other, while the gearing which leads to the segmental piece D is adapted to bring about a considerably more rapid movement of the segmental piece D than the segmental piece E and the part B⁵ undergo.

The difference in the ratios of transmission given is so determined that the part B⁵ and with it the firing tongue b^4 is adjusted to the angle of advanced ignition corresponding to the firing delay, when the segmental piece D and with it the mark d' has been moved out of its middle position, by an amount which corresponds to the angle of roll. On the shaft F' is also keyed an indicating drum F³ provided with a scale of degrees on which the amount of rotation of the hand wheel F can be read off by means of a sliding mark.

The shaft F' is connected to a co-axial shaft H by means of a clutch F⁴, H' which can be thrown into and out of operation and the shaft H is connected in its turn with the transmitter J of a long distance indicating apparatus through a sun and planet gear, h^2 , i' , i^2 , one of the middle wheels of which, i^2 , is adjustable by means of a milled head K and an indicating apparatus h' , h^2 to correspond to the range of the target.

The transmitter J is electrically connected to the receiver which is mounted on the gun and which reproduces, true to angle, the rotation imparted to the transmitter J. In the vicinity of the indicating apparatus M of the receiver is located an indicating apparatus N which belongs to the elevating gear of the gun and by the aid of which the elevation indicated by the indicating apparatus M of the receiver, can be imparted to the gun-barrel N'. In the breech block of the gun-barrel N' is placed a winding n^2 for the excitation of a firing magnet, and the ends of this winding n^2 are connected through the firing tongues b^3 and b^4 and a hand-operated switch P to a source of current.

In the consideration of the working of the above described fire control apparatus it will be assumed that the telescope B' and the gun barrel N' are adjusted for traverse on the target and that the ship, with the switch P open, is making rolling movements about its horizontal floating position, the course of these rolling movements being indicated by the rolling curve Q shown at Fig. 2. In Fig. 2 also the magnitudes measured in the direction of the axis of the abscissas, show the times, and the magnitudes inserted in the direction of the axis of the ordinates, the corresponding angles of roll.

When the gun barrel N' is to be adjusted by the aid of the described fire control apparatus to the elevation corresponding to the range of the target and fired at an instant denoted in Fig. 2 by q' , which lies in

the vicinity of the point of reversal of the rolling curve and for example by a small period of time behind the instant at which the points of reversal are passed through when the ship rolls, the elevations previously imparted to the gun barrel N' and corresponding to the range of the target must be modified by an angle which is equal to the oblique position of the ship which exists just at the point of firing.

Consequently, firstly by rotating the milled head K, the transmitter J and with it also the indicating apparatus M of the receiver mounted on the gun, are adjusted to the angle of elevation corresponding to the range of the target and the clutch F⁴, H' is then thrown into operation. If the ship now rolls out of the middle position, the pointer B² which is held in its vertical position by the gyroscope and with it the mark b^8 , execute relatively to the mark e' a relative rolling movement, by the amount of the angle of roll. This rolling movement is also taken part in by the firing tongue b^3 rigidly connected to the pointer B² and it moves away from the firing tongue b^4 also by the amount of the angle of roll.

Notice is now taken, to which side the mark b^8 of the pointer B² makes the relative movement, in respect of the oppositely situated marks e' , e^2 and e^3 and the hand wheel F is then rotated in such a direction that the mark e^2 for example, past which the pointer B² with the mark b^8 has moved in its relative movement, follows the pointer B² and with it the mark b^8 , up to the point of reversal. As soon as this point is reached, the hand wheel F is stopped, the segmental piece E with its mark e^2 thus being moved out of its middle position through an angle which is equal to the angle of roll passed through by the pointer B², with respect to the casing A, less the angle formed by the angular distance apart of the marks e^2 , e' .

The rotation of the hand wheel F imparts movement in addition to that imparted to the mark e^2 to the firing tongue b^4 mounted on the part B⁵, said tongue b^4 moving under the above given ratio of transmission through the same angle through which the segmental piece E and with it the mark e^2 moved. The result of this is, that the firing tongue b^4 , at the instant of the reversal of the relative movement of the pointer B², that is to say, at the instant of stopping the hand wheel F, is disant from the firing tongue b^3 by the difference of the angle of roll and the angle of movement of the segmental piece E, that is to say, by the same angle as the pointer mark b^8 is from the opposite, middle mark e' .

The movement of the hand wheel F is also transmitted through the gearing F', F⁴, H', H, h^2 , i' , i^2 to the transmitter J and consequently to the indicating apparatus M

of the receiver mounted on the gun. The receiver is at the same time rotated out of the elevation imparted to it corresponding to the range of the target, through an additional angle which is equal to the angle of movement of the segmental piece E, that is to say, the angle of roll passed through by the pointer B^2 , diminished by the angle determined by the distance e^2 , e' . This additional angle is added to or subtracted from the angle corresponding to the range of the target, according as the hand wheel F is rotated in one direction on the downward roll or in the other direction on the upward roll.

The gun layer whose duty is to rotate the elevating gear then adjusts the gun barrel N' to the elevation shown on the indicating apparatus M of the receiver. The time at his disposal to do this is somewhat less than the time which elapses from the instant in which the marks e^2 and b^8 were opposite each other at the point of reversal, up to the instant in which the pointer mark b^8 in the further course of the rolling movement reaches the middle mark e' , now fixed with respect to the casing A.

When he has adjusted the gun barrel N' during this time, he gives by a signaling device (not shown), a corresponding signal to the observing station, and, at this station, the switch P is then closed. As soon as the pointer mark b^8 is opposite the middle mark e' , when the course of the rolling movement is as given, the two firing tongues b^4 and b^8 are opposite each other as they, as already stated, were removed from each other at the point of reversal, by the same angle as the two marks b^8 and e' , and the gun will accordingly be fired at this instant.

As the gun barrel N' has an elevation imparted to it in respect of the ship, forming its emplacement, which is equal to the angle of elevation corresponding to the range of the target, modified by the angle of roll fixed by the position of the mark e' , and the ship, at the instant of firing the shot, is inclined to its horizontal floating position, by the angle of roll determined by the position of the mark e' , the gun-barrel N' just possesses, at the instant of firing the shot, the elevation with respect to a horizontal plane, which corresponds to the range of the target.

As will be clear without any further description, the mark b^8 can also be followed by the mark e' and the firing of the shot at the point of reversal of the rolling movement itself so allowed to take place.

Instead of controlling the firing by the aid of the indicating apparatus formed by the marks b^8 , e' , e^2 , and e^3 , it may be controlled also by the aid of the fire control apparatus described, by using the indicating apparatus containing the marks b^7 and d^7 , which is most conveniently done when the

ship makes a rolling movement which takes place uniformly according to the sine law. In this case the gun barrel N' will be adjusted to the elevation corresponding to the range of the target, using the indicating apparatus formed by the marks b^7 and d^7 and fired at an instant which lies by the amount of the firing delay corresponding to the angle of roll in advance of the instant at which the ship passes through the horizontal floating position. For this purpose firstly the clutch F^4 , H' is thrown out of operation. The transmitter J is then adjusted by means of the milled head K to the angle of elevation corresponding to the range of the target and this adjustment of the transmitter J results in a corresponding adjustment of the receiver. The gun barrel N' is next adjusted to the elevation corresponding to the range of the target and which can be read off on the indicating apparatus M of the receiver.

As soon as it has been ascertained at the observing station by the aid of a return signaling apparatus (not shown), that the gun barrel has been adjusted to the elevation corresponding to the range of the target, the hand wheel F and with it the toothed sector D positively connected thereto are so rotated that the mark d^7 thereon follows the pointer mark b^7 and is exactly opposite it at the point of reversal of its relative movement and at this moment the hand wheel F is stopped. The rotation of the hand wheel F is also taken part in by the part B^5 positively connected thereto and carrying the firing tongue b^4 and the said firing tongue b^4 , as the ratios of transmission in question are selected as before stated, is adjusted with respect to the firing tongue b^8 to an angle of advanced ignition corresponding to the angle of rotation (angle of roll) just present of the mark d^7 .

If now the firing switch P be closed, the gun, as both the firing tongues are adjusted to the angle of advanced ignition, will be fired at an instant, which lies by a time corresponding to the firing delay in advance of the instant at which the pointer B^2 has again reached its middle position, that is to say in which the ship passes through its horizontal floating position.

The fire control apparatus affords primarily the possibility of firing the gun by the aid of the indicating apparatus above described, automatically exactly at one of the points of reversal or in the vicinity of one of the points of reversal of the rolling movement. This fact is of special importance when the rolling movements do not take place regularly, but irregularly (see Fig. 2). In this case it was heretofore necessary, when it was desired nevertheless to fire the gun in the vicinity of the middle floating position to estimate the angle of ad-

vanced ignition necessary, as the speed of the passage of the ship through the middle floating position when the rolling movements are irregular is beyond calculation and undesirable errors in the laying of the guns were therefore unavoidable. According to the present invention however these errors are eliminated, as the movement of the ship in the vicinity of the points of reversal takes place at such a low speed that the advanced ignition may be dispensed with or a constant advanced ignition of small amount may be provided at the fire control apparatus.

The method of firing above described, shortly behind one of the points of reversal of the rolling movement, possesses the further advantage, that the elevating gear and with it the gun barrel even shortly before the firing of the shot, makes no further movement with respect to the ship and that consequently jumps are avoided which arise from the oscillations of the gun barrel which occur when the said gun barrel is moved.

The fire control apparatus according to the present invention possesses the further advantage that the gun layer stationed at the observing station whose duty is to adjust the transmitter is able to ascertain with special ease the continual variation in the speed of the rolling and the approximation of the point of reversal by the aid of the indicating apparatus (b^8 , e^2 , or e^3) located at the observing station and is consequently enabled to adjust the transmitter of the long distance indicating apparatus leading to the gun with particularly great continuity and certainty.

In addition to this the fire control apparatus according to the present invention affords the advantage of a particularly high readiness of fire, of the gun equipped therewith. As it may be assumed that for the comparatively short time which is consumed, the telescope retains its position of being trained on the target under the action of the gyroscope and further marking of the target according to the first sight taken of the target by the aid of the telescope is no longer necessary, it is clear, that the present fire control apparatus permits of the adjustment of the gun and the firing thereof in the vicinity of the points of reversal, even when the target is temporarily obscured by smoke.

Further the fire control apparatus according to this invention also enables the general arrangement to be so constructed that the firing is effected automatically if desired, either in the vicinity of the points of reversal or on the passage of the ship through the middle floating position.

Without altering any of the essential features of the invention the equality of the ratios of transmission of the gearing for driving the segmental piece E and the part B⁵

may be dispensed with and the transmission of the gearing for the segmental piece E so selected that this latter is moved at a different speed relatively to the part B⁵.

Furthermore the fire control apparatus above described can be so modified as shown in Fig. 4 that instead of a single pair of firing tongues b^3 and b^4 , two pairs b^3 and b^4 and b^9 and b^{10} are used, of which one pair b^3 and b^4 is intended for the firing of the gun during the upward roll and the other pair b^9 and b^{10} for the firing of the gun during the downward roll. The firing tongues b^9 and b^{10} are connected with a source of current in the manner shown in Fig. 4. In this case it is necessary to provide a switch R by means of which the pair of tongues which is just out of use, is to be switched out of circuit.

Finally instead of the long distance indicating apparatus formed by the transmitter J and the receiver, a long distance controlling apparatus may be employed, by means of which the gun barrel is automatically adjusted according to the adjustment of the corresponding transmitter.

It is also possible for the purpose of shifting the firing point to make the marks e^2 and e^3 adjustable in respect to the mark e^1 .

Claims.

1. A fire control apparatus for naval guns comprising the combination with a gun barrel, a sighting telescope, a stabilized shaft carrying said telescope, means for stabilizing said shaft, a control device between said sighting telescope and gun comprising a transmitter positioned adjacent the telescope, means including a range device for adjusting said transmitter, a receiver positioned adjacent the gun and electrical conductors connecting said transmitter to said receiver whereby the range imparted to said transmitter may be transmitted to the receiver and means for correcting the adjustment imparted to said transmitter corresponding to the angle of roll.

2. A fire control apparatus for naval guns comprising in combination with an adjustable gun barrel, a transmitter forming part of a distance electrical control device, a receiver positioned at said gun, means operatively connecting said transmitter to said receiver, means including a range device for adjusting said transmitter and means operatively connected to said transmitter for measuring the angle of roll and for imparting an additional adjustment to the transmitter corresponding to this angle of roll, substantially as described.

3. A fire control apparatus for naval guns which comprises the combination with an angularly adjustable gun barrel of means for adjusting the angle of said gun barrel, said means comprising a transmitter, a receiver positioned adjacent said gun barrel,

electrical means operatively connecting said transmitter to said receiver, means including a range device for adjusting said transmitter, and means for imparting an additional
 5 adjustment, corresponding to the angle of roll to said transmitter, said means comprising a sighting telescope, a stabilizable shaft carrying said sighting telescope, means for stabilizing said shaft, a pointer rigidly
 10 supported by said shaft, cooperating marks, an adjustable member carrying said cooperating marks, means for operating said adjustable member, said operating means also serving to adjust said transmitter, as
 15 and for the purpose set forth.

4. A fire control apparatus for naval guns which comprises in combination with a gun, a distance control device embodying a transmitter, a receiver positioned at the gun,
 20 means connecting said transmitter to said receiver for synchronous operation, means including a range device for adjusting said transmitter, a sighting telescope, a stabilizable shaft carrying said sighting telescope,
 25 means for stabilizing said shaft, a firing tongue controlled by said stabilizing means a cooperating firing tongue, means for adjusting said cooperating firing tongue, a firing device mounted at said gun, a circuit
 30 connecting said firing tongues to said firing device, means for imparting an additional adjustment to said transmitter, said last mentioned means causing the adjustment of said cooperating firing tongue.

5. A fire control apparatus for naval guns which comprises in combination with a gun, a distance control device embodying a transmitter, a receiver positioned at the gun,
 40 means connecting said transmitter to said receiver for synchronous operation, means including a range device for adjusting said transmitter, a sighting telescope, a stabilizable shaft carrying said sighting telescope,
 45 means for stabilizing said shaft, a firing tongue controlled by said stabilizing means, a cooperating firing tongue, a pointer rigidly mounted on said stabilizable shaft, a mark carried by said pointer, an adjustable segment, cooperating marks carried by said ad-
 50 justable segment, and means for moving said adjustable segment and for adjusting said cooperating firing tongue, said means being operatively connected to the transmitter for imparting thereto an additional
 55 adjustment corresponding to the angle of roll.

6. A fire control apparatus for naval guns comprising the combination with an adjustable gun barrel of a long distance control
 60 device embodying a transmitter, a receiver positioned adjacent said gun barrel, means connecting said transmitter and said receiver for synchronous operation, means for adjusting said transmitter corresponding to
 65 the range, and means for imparting an addi-

tional adjustment to said transmitter corresponding to the angle of roll, said last mentioned means comprising a stabilizable shaft, means for stabilizing said shaft, a
 70 pointer rigidly mounted on said shaft, a firing tongue controlled by said stabilizing means, a cooperating firing tongue, a mark carried by said pointer, an adjustable mark cooperating with said first mentioned mark, said cooperating mark and said cooperating
 75 firing tongue taking part in the rolling movement of the ship and means for adjusting said cooperating firing tongue and said cooperating mark, said means simultaneously imparting an additional adjust-
 80 ment to the transmitter, the cooperating mark having a greater ratio of movement than the cooperating firing tongue whereby the cooperating firing tongue may be adjusted to an angle which corresponds to the
 85 angle of advanced ignition.

7. A fire control apparatus for naval guns comprising in combination with an angularly adjustable gun barrel a distance control device embodying a transmitter, and a
 90 receiver mounted adjacent the gun barrel, means for adjusting said transmitter corresponding to the range, means for imparting an additional adjustment to said transmitter, said means comprising a stabilizable
 95 shaft, means for stabilizing said shaft, a sighting telescope carried by said stabilizable shaft, a pointer carried by said stabilizable shaft, a mark carried by said pointer, a pair of cooperating marks positioned
 100 symmetrically to the point with which the first mentioned mark registers in the middle floating position of the ship, means for adjusting said pair of marks, said pair of cooperating marks being spaced a distance
 105 from the middle position of the first mentioned mark which corresponds to the angle of rotation passed through by the sighting telescope with respect to the hull of the ship from the instant of the reversal of the rolling
 110 movement to the instant of the firing of the gun.

8. A fire control apparatus for naval guns comprising in combination with an angularly adjustable gun barrel a distance control
 115 device embodying a transmitter, a receiver mounted adjacent the gun barrel, means for adjusting said transmitter corresponding to the range, means for imparting an additional adjustment to said transmitter, said means comprising a stabilizable
 120 shaft, means for stabilizing said shaft, a sighting telescope carried by said stabilizable shaft, a pointer carried by said stabilizable shaft, a mark carried by said pointer, a pair of cooperating marks positioned
 125 symmetrically to the point with which the first mentioned mark registers in the middle floating position of the ship, a segment carrying said pair of marks, means for adjust-
 130

ing said marks with respect to said segment, means for adjusting said segment, said pair of cooperating marks being spaced a distance from the middle position of the first 5 mentioned mark which corresponds to the angle of rotation passed through by the sighting telescope with respect to the hull of the ship from the instant of the reversal of the rolling movement to the instant of the 10 firing of the gun.

9. A fire control apparatus for naval guns comprising in combination with an adjustable gun barrel an electrical distance control device comprising a transmitter, a receiver 15 positioned adjacent the gun barrel and electric conductors operatively connecting said transmitter and receiver, means for adjusting said transmitter corresponding to the range, means for imparting an additional 20 adjustment to said transmitter corresponding to the angle of roll of the ship, said

means comprising a sighting device, a stabilizable shaft carrying said sighting device, means for stabilizing said shaft, a pointer 25 rigidly mounted on said stabilizable shaft, marks carried by said pointer, cooperating marks, means for adjusting said cooperating marks, two pairs of firing tongues, one of each pair of firing tongues being controlled 30 by said stabilizing means, the other of each pair of firing tongues being adjustable, means for adjusting said last mentioned firing tongues and for moving said adjustable marks, said means being connected to the transmitter for imparting thereto its addi- 35 tional adjustment.

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

Dr. WALTHER AKEMANN.

In presence of—

HANS GOTTMANN,
JOHANN DECKERS.