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W. AKEMANN

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FIRE CONTROL APPARATUS FOR NAVAL GUNS

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2 Sheets-Sheet 1

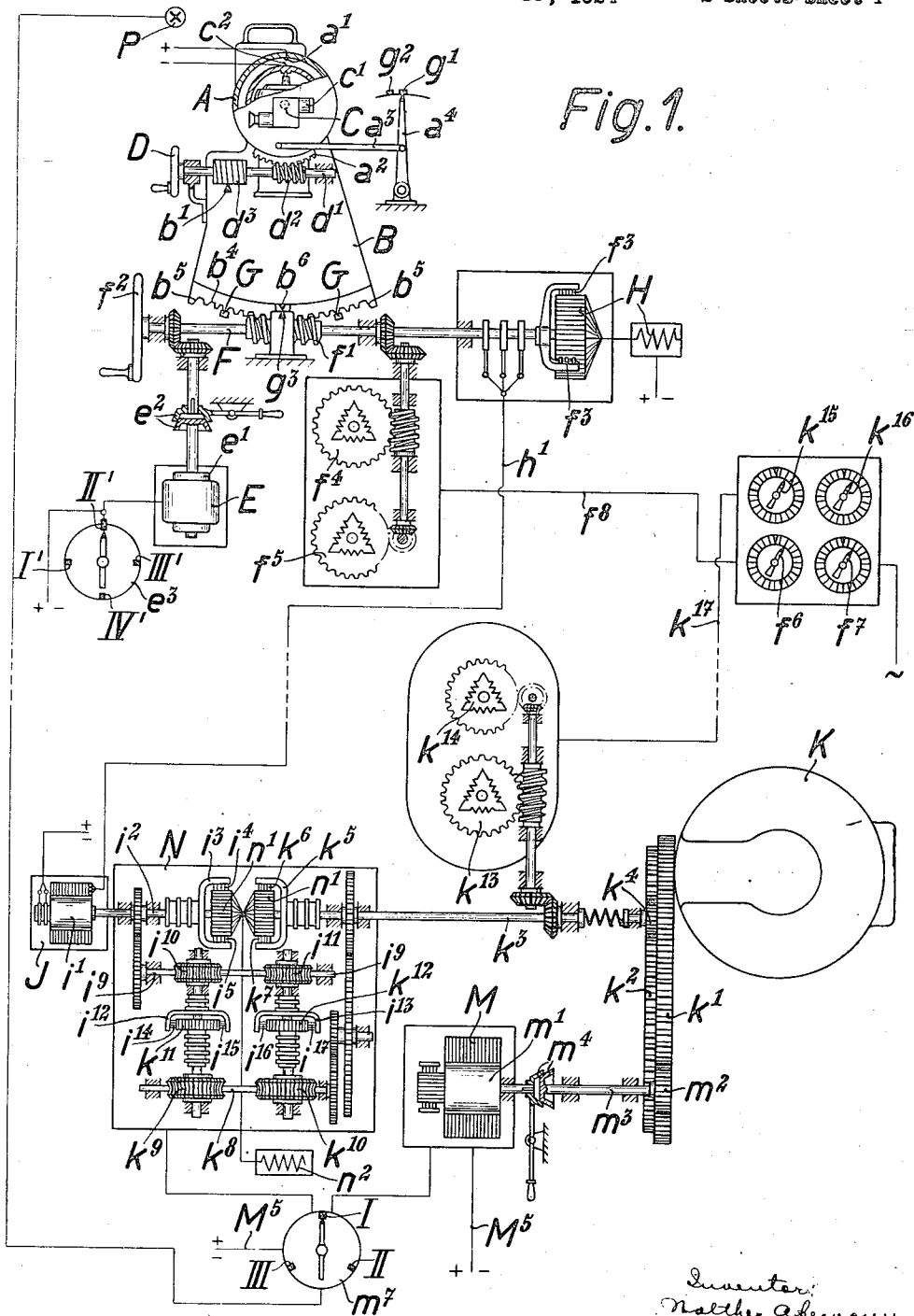


Fig. 1.

Inventor:
Walter Akemann,
By: *Knapf & Co.* Attys.

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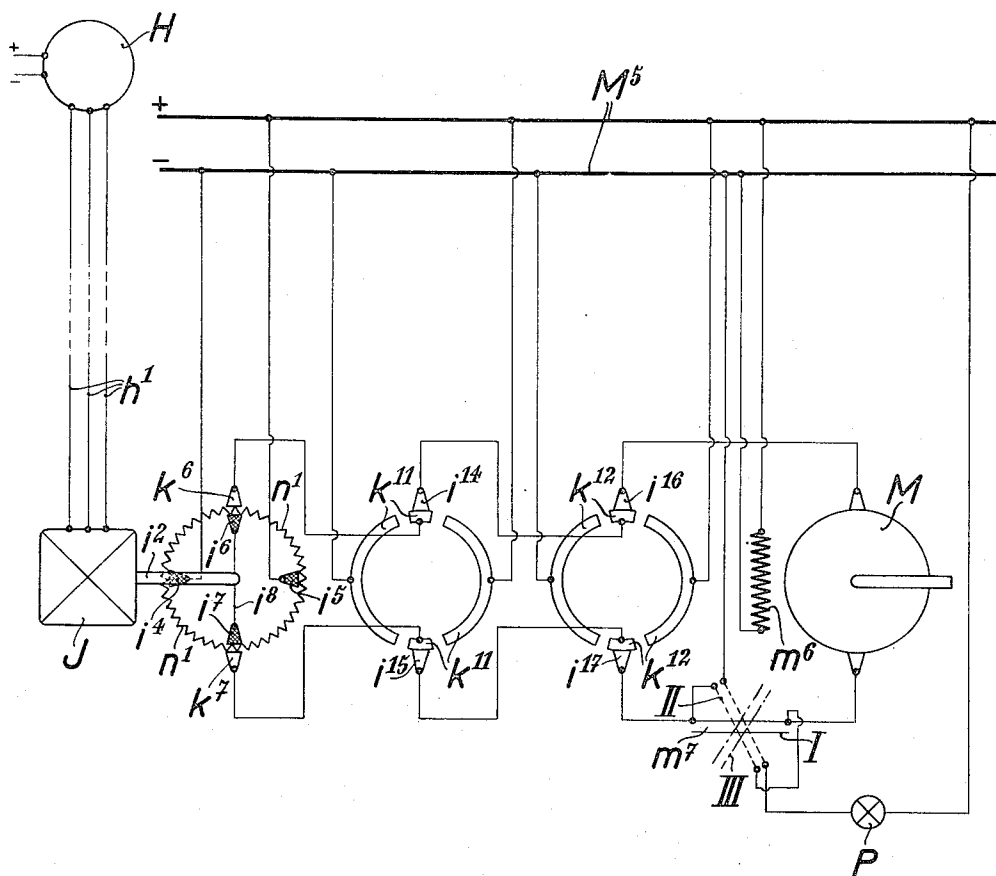
W. AKEMANN

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2 Sheets-Sheet 2

Fig. 2.



Inventor:
Walter A. Akemann,
By *Kemp* atty.

UNITED STATES PATENT OFFICE.

WALTHER AKEMANN, OF BERLIN-DAHLEM, GERMANY, ASSIGNOR TO FRIED. KRUPP
AKTIENGESELLSCHAFT, OF ESSEN-ON-THE-RUHR, GERMANY.

FIRE-CONTROL APPARATUS FOR NAVAL GUNS.

Application filed March 13, 1924. Serial No. 699,026.

To all whom it may concern:

Be it known that I, WALTHER AKEMANN, residing at Berlin-Dahlem, Germany, a citizen of the German Republic, have invented a certain new and useful Improvement in Fire-Control Apparatus for Naval Guns, of which the following is a specification.

The invention relates to a fire control apparatus for naval guns which is provided with a firing device having a stabilized and a non-stabilized firing tongue, and in which a motor is provided serving for the common adjustment of the non-stabilized firing tongue and, at least, one gun barrel.

The invention has for its object to so improve apparatus of this kind that it enables the requirements of the firing device to be allowed for in a particularly satisfying manner and to impart to a single gun, or to a plurality of guns, elevations which are synchronous to one another and take place true in angle with respect to the movements of the transmitter of the long distance adjusting apparatus.

With this end in view the invention consists in the arrangement, construction and combination of parts to be hereinafter described and particularly pointed out in the appended claims.

The invention will now be described in detail with reference to the accompanying drawing which diagrammatically illustrates, by way of example, an embodiment of the subject-matter of the invention and in which:

Fig. 1 illustrates the arrangement and connection of the members of the fire control apparatus, and

Fig. 2 a wiring diagram of the electric installation forming part of the fire control apparatus.

The whole fire control apparatus is composed of two installations one of which is situated in an observing station and the other in the gun station.

In the observing station of the ship is arranged a Cardan firing gyroscope the casing A of which is arranged on a sector B and is adjustable, according to the range of the target, on one of the horizontal Cardan axes, C. The sector B in its turn, is adapted to be swung about the same Cardan axis C. On the end projecting beyond the casing A, of the stabilized Cardan axis

C is fixed a sighting telescope c^1 . On the casing A is further provided one, a^1 , of the firing tongues of an automatic firing device the counter tongue c^2 of which is adjustably mounted on a part which is stabilized by the gyroscope. The adjustability, not forming part of the invention and therefore not illustrated, of the counter tongue c^2 has the object of automatically allowing for the influence of the velocity of roll on the angle of advanced ignition and thus on the angle of elevation, in the moment of the shot.

A hand wheel D mounted for rotation on the sector B serves for adjusting the casing A and therewith the tongue a^1 to the angle of elevation according to the range of the target. The shaft d^1 of said hand wheel D is positively connected to the casing A by a worm gear $d^2 a^2$.

On the shaft d^1 is fixed a drum d^3 showing a range scale and co-operating with a fixed reading-off mark b^1 . By means of a rod a^3 the casing A is further connected to a pivoted pointer a^4 the point of which co-operates with two marks g^1 and g^2 fixed on a stationary part and including an angular distance of 3° for instance.

For adjusting the sector B there is provided firstly a continuous current motor E e^1 the armature e^1 of which is positively connected to a shaft F by the intermediary of a releasable clutch e^2 . The shaft F is connected to the sector B by means of a worm gear $f^1 b^1$. A hand-operated switch e^3 having four switch positions is allotted to the motor E e^1 . The sector B shows two lugs b^5 which co-operate with fixed abutments G and limit the swinging movement of the sector B on both sides. The sector B further carries a mark b^6 which indicates in co-operation with a fixed mark g^3 , whether the sector B takes its middle position or not. Secondly, a hand wheel f^2 mounted on one end of the shaft F serves for adjusting the sector B, said hand wheel loosely rotating with the shaft F when the latter is driven by the motor E e^1 , and being made use of when the clutch e^2 has been thrown out. On the other end of the shaft F are mounted three brushes f^3 staggered to one another by 120° and forming the rotating part of a transmitter H excited by continuous current. A conductor h^1 so connects said brushes to the armature z^1 of the corresponding receiver likewise supplied

ly continuous current that it will rotate synchronously with the brushes f^3 . To the shaft F, further, are positively connected the armatures f^4 , f^5 of an indicating device
 5 working after the coarse and fine system, to which armatures are connected by a conductor f^8 the armatures, carrying the coarse and fine pointers f^6 , f^7 , of the corresponding receivers.

10 The receiver J i^1 is mounted in the gun station and has for its object to impart to the gun barrel K of the gun to be trained in elevation, an adjustment corresponding to the adjustment of the sighting telescope
 15 c^1 , the portion situated in the gun station, of the fire control apparatus being arranged in the following manner.

The gun barrel K which is mounted by trunnions in a mounting capable of lateral
 20 training also, is provided with a toothed elevating arc k^1 and an auxiliary toothed arc k^2 . The arc k^1 is in mesh with a pinion m^2 driven by the elevating motor M m^1 which is a continuous current motor. A
 25 releasable clutch m^4 is interposed in the shaft m^3 leading from the armature m^1 of the motor M m^1 to the pinion m^2 .

For connecting the elevating motor M m^1 to its source of continuous current M^5 a
 30 switch device N is provided the arrangement and connection of the members of which is to be seen in Fig. 1 while its wiring diagram is more particularly illustrated in Fig. 2. Referring to Fig. 1, i^2 denotes the arma-
 35 ture shaft of the receiver J i^1 while i^3 denotes a holder mounted on the shaft i^2 and carrying four brushes i^4 i^5 i^6 i^7 . n^1 is a stationary commutator-like body, n^2 is a resistance closed in itself the parts of which
 40 are conductively connected to the segments of the body n^1 . k^3 is a shaft carrying a pinion k^4 while k^5 denotes a common holder of two brushes k^6 and k^7 which is mounted
 45 on the shaft k^3 , said brushes being also allotted to said body n^1 . The pinion k^4 is in mesh with the auxiliary arc k^2 . Two of the brushes, i^4 i^5 , are connected to the source of current M^5 by slip rings, the two other
 50 brushes, i^6 , i^7 , are connected to one another by a conductor i^8 . A shaft i^9 is positively connected to the armature shaft i^2 by means of a reduction gear, said shaft i^9 serving, by
 55 intermediary of two worm gears i^{10} and i^{11} , for driving two brush holders i^{12} and i^{13} each of which carries two brushes i^{14} , i^{15} and i^{16} , i^{17} , respectively. The ratios of transmission are so chosen that a whole revolution of the brush holder i^{13} corresponds to a whole multiple of revolutions of the brush
 60 holder i^{12} and that a whole revolution of this holder i^{12} corresponds to a whole multiple of revolutions of the armature shaft i^2 . In a corresponding manner a shaft k^8 connected to the shaft k^3 by means of a gear
 65 train, drives the same reduction of speed,

the shaft i^8 driving two contact rings k^{11} and k^{12} through the intermediary of two worm gears k^9 and k^{10} similar to said worm gears i^{10} i^{11} . The pairs of brushes i^{14} i^{15} and i^{16} i^{17} are in contact with the rings k^{11} and k^{12} respectively. Therefore, if the
 70 angular velocities of the shafts i^2 and k^3 are equal to one another the respective contact rings and brushes will likewise rotate with equal angular velocity.

The elevating motor M m^1 is excited by a winding m^5 supplied by the source of continuous current M^5 , Fig. 2.

The contact rings have embedded in their periphery contact pieces showing the dimensions illustrated in Fig. 2, which contact pieces are connected to each other or to the source of current M^5 , respectively, in the manner likewise shown in Fig. 2. A
 80 hand-operated switch m^7 adjustable in three switch positions, is contained in the armature circuit. In the switch position I the circuit containing the armature m^1 of the elevating motor is closed, Fig. 2; in position II, in addition, a circuit is closed which
 85 causes a signal lamp P situated in the observing station to light up, and in position III all conduits leading to the switch m^7 are cut off.

The shaft k^3 has further positively connected to it in the manner shown in Fig. 1 the transmitter armatures k^{13} k^{14} of a long distance indicating apparatus to which
 90 armatures are connected the armatures of the corresponding receivers by a conductor k^{17} . Said receiver armatures which carry the coarse and fine pointers k^{15} k^{16} are enclosed, together with the receivers carrying the coarse and fine pointers f^6 f^7 in a common casing. This casing is situated in the
 95 observing station but may also be placed in the gun station.

In describing the working of the hereinbefore described fire control apparatus it may be supposed that the gun barrel K assumes its horizontal loading position, that the mark b^6 of the sector B is opposite the mark g^3 and that the mark b^1 belonging to the range scale of the drum d^3 shows the range zero. It may be further supposed that
 100 the two switches e^3 and m^7 take their cut-off position and that the gyroscope is in motion. If now while the ship is rolling, the gun barrel K, already laterally trained, is to have imparted to it the elevation corresponding to the range of the target relative to a horizontal plane and to be fixed automatically, prior to its passage through the horizontal floating position by an amount
 105 of time corresponding to the firing delay, then firstly the casing A of the gyroscope firing device and therewith the firing tongue a^1 mounted thereon and the pivoted pointer a^4 are adjusted to the elevation angle corresponding to the range of the target, by ro-
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tating the hand wheel D. Then the sector B is swung together with the casing A which is stationary relatively to it by means of the self-locking worm gear $d^2 a^2$, by rotating the hand wheel f^2 , with the clutch c^2 thrown out, about the Cardan axis C until the pointer a^4 partaking in this movement, will be opposite the so-called "ready" mark g^2 . The rotation of the hand wheel f^2 is taken part in by the brushes f^3 mounted on the shaft F, of the transmitter H which brushes cause, in their turn, by the intermediary of the wire h^1 , a synchronous rotation, true in angle, of the armature i^1 of the corresponding receiver J i^1 . The rotation of the armature i^1 is so transmitted by the shaft i^2 and the interposed gear to the brush holders i^3 , i^{12} and i^{13} that the angle of rotation of the holder i^{12} will be a multiple of the angle of rotation of the holder i^{13} and that the angle of rotation of holder i^3 will be a multiple of that of holder i^{12} . Besides, the described rotation of the hand wheel f^2 causes the coarse and fine pointers f^4 f^5 of the long distance indicating apparatus annexed to shaft F to rotate. The coarse and fine pointers f^6 f^7 of the receiver connected thereto by the conductor f^8 thus take an adjustment which indicate the angular position of the sector B.

During these operations the gun is loaded. As soon as the loading operation is completed the hand switch m^7 in the gun station is brought from its open position III into the so-called "running-in"-position I in which the winding of the armature m^1 of the elevating motor M m^1 is connected to the lagging switch device and thus to the source of current M⁹, see Fig. 2. Since the armature m^1 is connected to points of different potential owing to the rotation of the holders i^3 , i^{12} and i^{13} carrying the brushes i^4 to i^7 and i^{14} to i^{17} respectively, it begins to run and thereby swings the gun barrel K by the intermediary of the elevating gear m^2 h^1 about the horizontal trunnions (not shown). The rotation of the armature m^1 is also taken part in, by the intermediary of the gear h^2 h^4 h^3 , by the brush holder k^5 and the contact rings k^{11} , k^{12} in such a manner that one revolution of the contact ring k^{12} corresponds to a multiple of revolutions of the contact ring k^{11} , and one revolution of this ring k^{11} to a multiple of revolutions of the brush holder k^5 . The rotation of the armature m^1 is further transmitted to the coarse and fine transmitter k^{13} , k^{14} positively connected to the shaft k^3 and causes by means of the conductor k^{17} an adjustment of the coarse and fine pointers k^{15} , k^{16} of the corresponding coarse and fine receivers, which adjustment indicates the adjustment of the gun barrel K. The rotation of the armature m^1 lasts until the brush holder k^5 and the contact rings have

completed angular ways which are proportional to those of the brush holders i^3 , i^{12} , i^{13} . As soon as these angular ways have been completed all parts of the lagging switch device again assume the mutual position shown in Fig. 2 in which position the brushes are connected to points of equal potential and the armature m^1 is short-circuited. Therefore the latter comes to rest in this position after having completed an angular way which exactly corresponds to that of the adjustable part f^2 of the transmitter. The ratios of transmission of the gear m^2 are so determined that with the said angular motion the gun barrel has been turned by an angle equal to the adjustment of the sector B. As after the foregoing the sector B has been swung by the elevation angle minus 3° an elevation has been imparted to the gun barrel K which is equal to the elevation angle corresponding to the range of the target minus 3° . Besides, upon the rotation of the armature m^1 the coarse and fine pointers k^{15} , k^{16} have been turned by angles which exactly correspond to the turning angles of the coarse and fine pointers f^6 , f^7 . After the motor M m^1 has come to rest the two pairs of pointers f^6 f^7 and k^{15} k^{16} therefore show exactly the same adjustment and thereby indicate that the gun barrel K has undergone the elevation corresponding to the adjustment of sector B.

As soon as the gun barrel K has been adjusted to the elevation angle corresponding to the range of the target minus 3° the hand switch m^7 is brought into the so-called "ready"-position denoted by II in which the signal lamp P in the observing station lights up and in which, besides, the armature m^1 is connected to the switch device N. The lighting up of the lamp P indicates to the gunner controlling the gyroscope firing device that the gun barrel K has been loaded and has undergone an elevation relative to its platform, which is reduced by 3° relative to the elevation corresponding to the range of the target. Now, while the side in question of the ship moves towards the lower reverse point of roll, the gunner first closes a hand switch, not shown, which is situated in the firing circuit containing the firing tongues a^1 c^2 and the firing magnet, not shown. Further he throws in the clutch e^2 . Thus, while the side in question of the ship is passing through the lower reverse point of roll, he brings the switch e^3 from the open position I' into one of the closed positions, denoted by II'. The motor E e^1 is thus supplied with current for one direction of rotation and after a short constant starting period will reach its normal number of revolutions, the shaft F thereby rotating with constant number of revolutions also. The rotation of shaft F is transmitted on the one hand by the transmitter

f^3 H, the receiver J i^1 , the switch device N to the elevating motor M m^1 and causes by the intermediary of the gear m^3 m^2 k^1 an additional elevation of the gun barrel K.

5 The elevating motor M m^1 rotates, after a constant starting period, likewise with a constant number of revolutions, the conditions being so chosen that the firing tongue a^1 swung by the motor E e^1 about the axis

10 C will again be opposite the counter tongue c^2 stabilized by the gyroscope, during the upwardly directed movement of roll, in a moment in which the ship is still inclined by the angle of advanced ignition relative to its horizontal floating position, and that the

15 tongue a^1 will again assume its angular position shown in Fig. 1 relative to the tongue c^2 when the ship lies horizontally. The tongue a^1 has thus additionally been swung

20 by 3° , during the upward movement of roll up to the horizontal floating position, by the motor E e^1 . As the adjustment of the tongue a^1 and that of the gun barrel are equal to one another, the gun barrel has also

25 been additionally elevated by 3° during the upward movement of roll up to the horizontal floating position and therefore assumes in this moment the elevation corresponding to the range of the target relative

30 to its platform. When, before the horizontal position is reached, the tongue a^1 touches the counter tongue c^2 in passing it, the firing circuit is closed and the shot is effected automatically. The projectile thus

35 leaves the gun barrel K with the given firing delay in that moment in which the ship is passing through the horizontal floating position.

After the shot has been fired the hand

40 switch, not shown, situated in the observing station and contained in the firing circuit, is opened and the motor E e^1 is set in rotation in the direction opposite to the first-described, by bringing the switch e^3 through

45 the open position III' into the closed position IV' causing this rotation. By the rotation of the armature e^1 the gun barrel K is swung back again into its horizontal loading position by the intermediary of the members f^3 H J i^1 N M m^1 . Besides, the pairs

50 of pointers f^6 f^7 and k^{15} k^{16} return to their initial position. As soon as the gun barrel K has reached the loading position, which is indicated in the observing station by the

55 marks b^6 and g^3 registering with each other, the hand switch e^3 in the observing station is brought into its open position I'. This causes the armature e^1 and thereby the gun barrel to come to standstill. Then, if necessary,

60 the formerly adjusted range is corrected for the next shot in the observing station by suitably turning the hand wheel D.

65 The initial adjustment of the non-stabilized firing tongue a^1 and of the gun barrel

K to an elevation angle which is equal to the elevation angle corresponding to the range of the target minus 3° is made in order to make it possible that the passage of the tongue a^1 past the stabilized counter tongue c^2 , upon the upward roll of the side in question of the ship, takes place with a velocity which is greater by a constant amount than the relative velocity of the tongue a^1 and c^2 caused by the velocity of roll of the ship.

70 For this increase in velocity by a constant amount of the tongue a^1 is suitable with regard to the properties of the (not illustrated) device for automatically regulating the angle of advanced ignition (device for

75 automatically adjusting the tongue c^2 relative to the Cardan ring carrying it) and is even necessary with small velocities of roll. For, this device which is not a subject-matter of this invention and therefore is not

80 illustrated, is able to work in a satisfying manner only if the non-stabilized firing tongue a^1 is moved past the stabilized tongue c^2 with practically uniform velocity not exceeding determined upper and lower limits.

The main advantage of the hereinbefore described invention resides in the extraordinarily increased exactness of adjustment due to the connection of a gyroscope firing device with motorially adjustable firing

85 tongue, to a switch device securing the adjustment of the elevating motor to a predetermined angular distance and in the extraordinarily increased firing velocity of the gun or the plurality of guns fitted with the described apparatus. This exactness of

90 adjustment is firstly based on the fact that inaccuracies in the synchronism of the armatures e^1 and i^1 are entirely obviated, since on the one hand, with motor drive too great

95 accelerations of the transmitter brushes f^3 will not arise during the starting period and since, on the other hand, the receiver armature i^1 has to deliver only a small turning moment in order to rotate the parts of little

100 mass of the switch device connected thereto, while the large energy required for adjusting the gun barrel is produced by the elevating motor which is controlled true in

105 angle by said switch device. The particularly increased firing velocity likewise attained results first of all from the fact that all the necessary adjustments may be made in the observing station already during the loading operation so that after loading it is

110 at once possible to impart to the gun barrel the required elevation by simply handling a hand switch.

Claims:

1. A fire control apparatus for naval guns, comprising a firing device having a stabilized and non-stabilized firing tongue, a main transmitter for transmitting angular movements, a common motor for driving said

125 non-stabilized firing tongue and said trans-

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mitter, a receiver in connection with said transmitter, a gun elevating motor, and a switch device controlled by said receiver and in turn controlling the angular movements of said elevating motor whereby said elevating motor is adapted to execute an angular movement equal to the angular movement of said transmitter.

2. A fire control apparatus for naval guns, comprising a firing device having a stabilized and non-stabilized firing tongue, a main transmitter for transmitting angular movements, a common motor for driving said non-stabilized firing tongue and said transmitter, a receiver in connection with said transmitter, a gun elevating motor, a switch device controlled by said receiver and in turn controlling the angular movements of said elevating motor whereby said elevating motor is adapted to execute an angular movement equal to the angular movement of said transmitter, an auxiliary transmitter positively actuated in consonance with said main transmitter, a second auxiliary trans-

mitter positively actuated by the gun, a receiver in connection with each of said auxiliary transmitters, and an indicator operated by each of said auxiliary-transmitter-connected receivers for indicating the relative angular movements of said main transmitter and said gun.

3. In a fire control apparatus according to claim 1, a circuit switch interposed between said gun elevating motor and said device, a signal lamp, and means whereby said circuit switch in one of its positions is adapted to close a circuit to said lamp.

4. In a fire control apparatus according to claim 1, a pointer actuated in consonance with said nonstabilized fire tongue, and a scale for cooperating with said pointer, said scale being provided with a zero mark and a "ready" mark spaced from each other by a small angular distance.

The foregoing specification signed at Berlin, Germany, this 25th day of February, 1924.

WALTHER AKEMANN.