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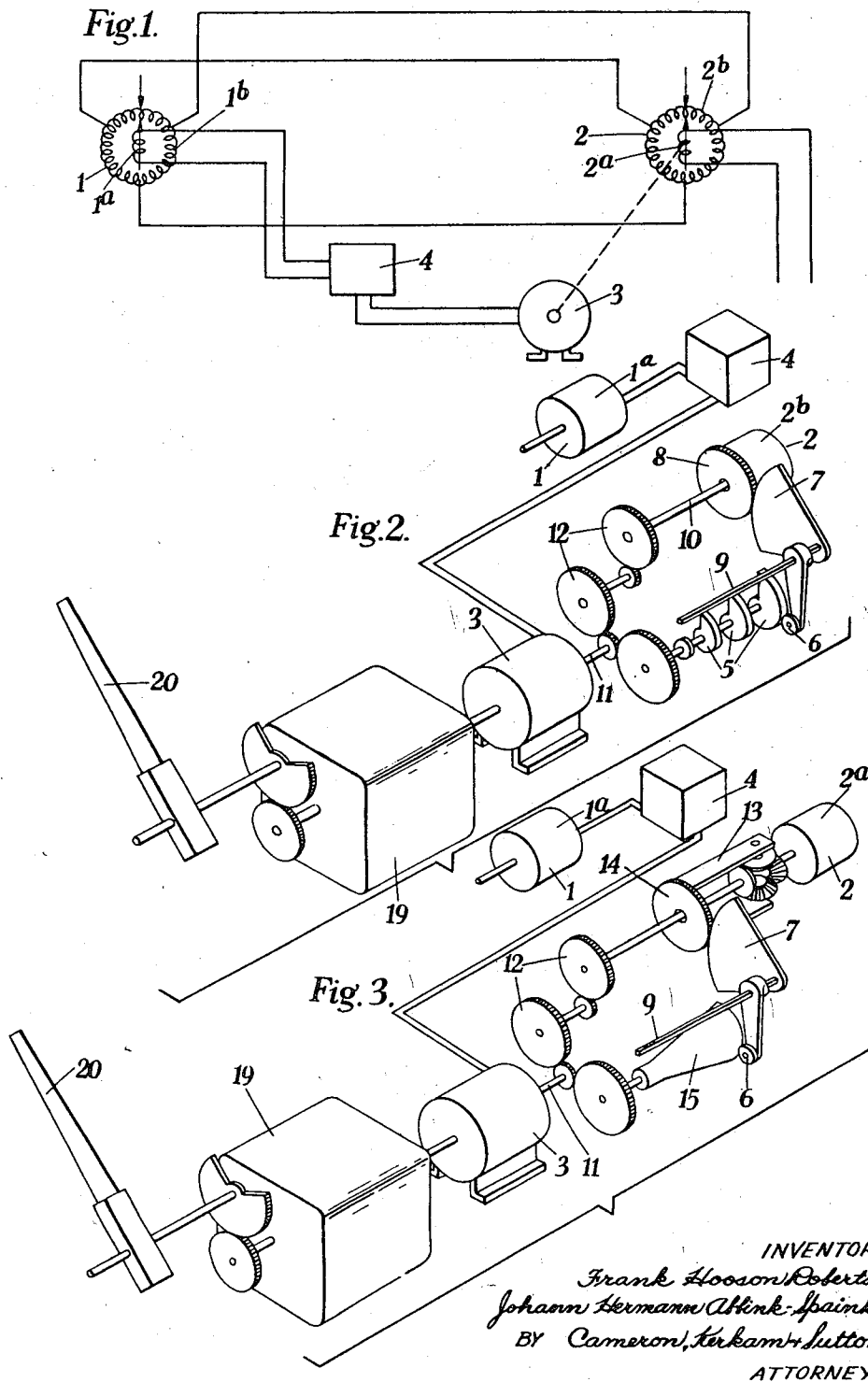
F. H. ROBERTS ET AL

2,412,356

APPARATUS FOR THE AUTOMATIC ADJUSTMENT OF THE ANGLE OF ELEVATION OF GUNS

Filed March 19, 1942

2 Sheets-Sheet 1



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Fig. 4.

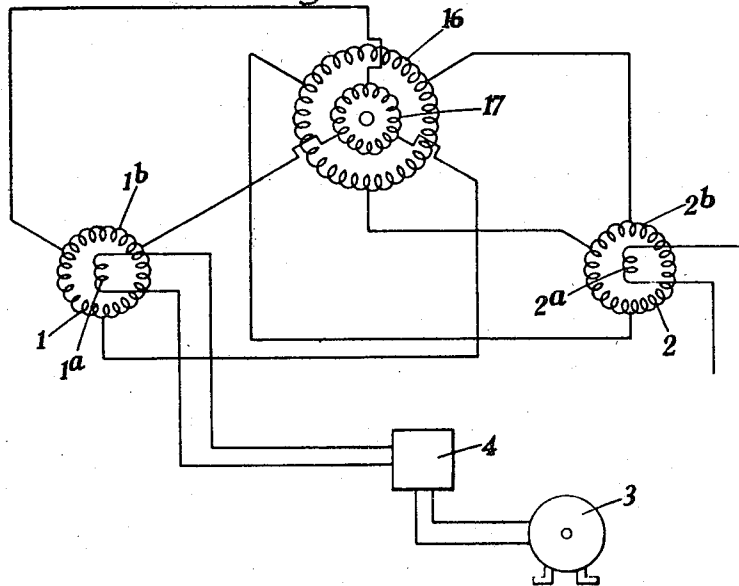
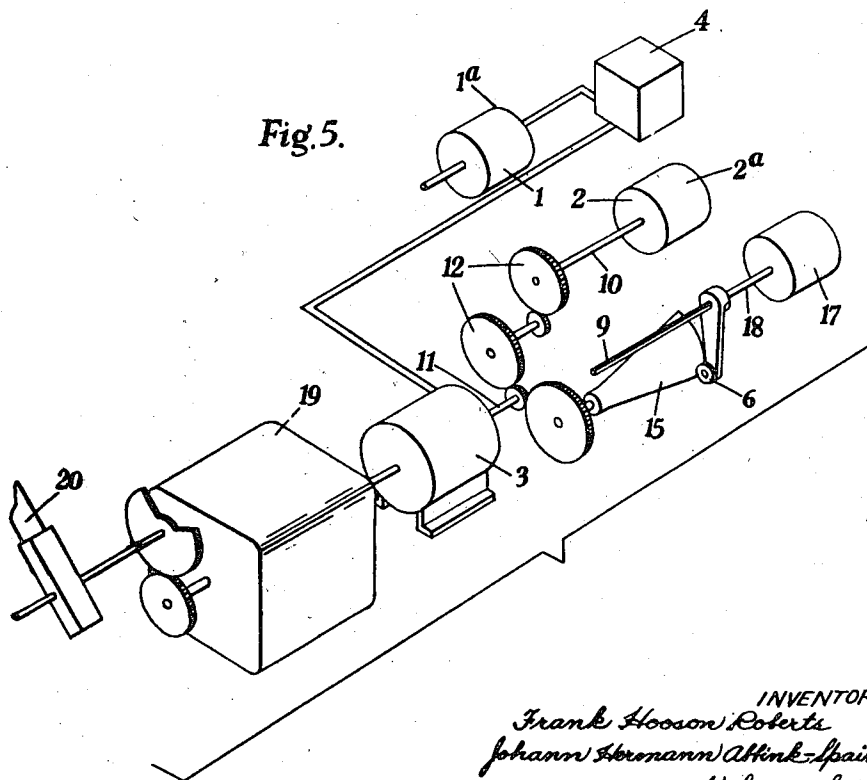


Fig. 5.



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APPARATUS FOR THE AUTOMATIC ADJUSTMENT OF THE ANGLE OF ELEVATION OF GUNS

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In Great Britain March 19, 1940.

7 Claims. (Cl. 89—41)

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This invention relates to apparatus for the automatic adjustment of the angle of elevation of guns or equivalent operation in which the angle of correction required is not necessarily constant. In this connection with guns the angle of correction differs for different elevations. That is to say, as applied to guns the present apparatus is adapted to impart into the elevational movement a correction necessary to compensate for falling off or variation in muzzle velocity as a result of barrel wear or due to other causes, or to correct for any variation in the range or length of trajectory due, for example, to atmospheric conditions, the chief object being to evolve apparatus which will effectively and automatically introduce the necessary correction in a simple manner. Another object of the invention is to apply correction to the elevating mechanism of the gun as a function of the elevation adjustment as supplied to the transmitter of the apparatus for the automatic adjustment of the elevation of the gun.

The invention is concerned with electrical transmission systems employing synchronous motors of the Selsyn type in the signal and follow-up part of the system, such motors being generally known as Selsyn units, one such unit constituting the initiating unit or transmitter and another similar unit the cancelling unit or receiver, both Selsyn units being so connected to a thermionic amplifier that the latter is controlled in its amplifying action according to the angular displacement existing between the rotors of the two units, the thermionic amplifier having its output applied to an electric motor associated with the rotor of the cancelling unit and serving, therefore, to bring the two Selsyn units again into coincidence, the electric motor being connected with the gun to be moved in elevation through the medium of an hydraulic power amplifier. Such a form of electric distant transmission system employing Selsyn units forms the subject of copending application for patent, Serial No. 435,356, filed March 19, 1942.

The invention is, however, applicable to other forms of electric transmission wherein movement of the gun is dependent upon the angular displacement between two members.

Referring to the drawings—

Figure 1 is a wiring diagram illustrating the manner in which the Selsyn transmitter and receiver units are connected with the follow-up motor and thermionic amplifier;

Figure 2 illustrates diagrammatically one mechanical method, in which the angular displacement between the two Selsyn units can be varied;

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Figure 3 is a similar view illustrating an alternative arrangement;

Figure 4 is a wiring diagram illustrating an electrical method of varying the angular displacement between the initiating and cancelling Selsyn units; and

Figure 5 illustrates diagrammatically the electrical method disclosed in Figure 4.

In the following description the invention is described as applied to a power transmission system including two Selsyn units 1 and 2 comprising rotors 1a and 2a and stators 1b and 2b, the two stators being electrically connected together, the windings of the rotor 2a of the Selsyn unit 2, usually referred to as the receiver or resetting unit, being connected with a source of A. C. supply, the windings of the other rotor 1a of the transmitter Selsyn unit being connected with an electric motor or the like 3 through the medium of a thermionic amplifier 4, the latter being controlled in its amplifying action according to the angular displacement existing between the rotors of the two Selsyn units, the armature of the motor 3 being mechanically coupled with the rotor 2a of the receiver unit so that rotation of the motor will eventually bring the rotors into coincidence, the electric motor, through the medium of an hydraulic power amplifier indicated diagrammatically at 19 in Figs. 2, 3 and 5 moving the gun 20 in elevation until such time as coincidence exists between the two Selsyn units, the direction of rotation of the electric motor being dependent upon the direction of displacement of the one rotor relative to the other.

If, therefore, there occurs an angular displacement between the two Selsyn units and if this displacement is increased or decreased by suitable means, an increased or decreased elevational movement will be imparted to the gun to compensate for variation in muzzle velocity or for any other purpose. With this purpose in view, this angular displacement is increased in the manner shown in Figure 2 by imparting rotational movement to the stator 2b of the receiver Selsyn unit through the medium of a system of cams 5 driven from the electric motor shaft, a cam follower 6, a toothed quadrant 7, and a pinion 8 associated with the stator 2b, the arrangement being such that the follower 6 can be brought into engagement with any one of the cams by sliding it along its support 9 to suit particular conditions, for example, to suit a particular muzzle velocity, thereby increasing or decreasing the number of revolutions of the motor 3 necessary to bring the two Selsyn units into coincidence and thus in-

creasing or decreasing the elevational movement imparted to the gun. In the above arrangement, the rotor 2a (compare Fig. 1) associated with stator 2b is attached to the shaft 10, and the receiver Selsyn unit is connected with the electric motor shaft 11 by a simple geared connection 12 but alternatively this connection may be in the form of a differential gear 13 as in the construction illustrated by Figure 3, and instead of rotating the stator to automatically increase or decrease the angular displacement between the units, the toothed quadrant 7 may be arranged to drive the outer member or planet carrying member 14 of the differential gear with the object of rotating the rotor 2a of the receiver Selsyn unit 2 to increase or decrease the angular displacement. Instead of using a number of cams, each having a different degree of lift as in Figure 2, a single cam 15 of tapering form may be substituted, such as for example, a camoid as commonly used in predictor mechanism, the follower 6 associated with the camoid being movable into any position on the cam surface to suit requirements. In this way, the number of revolutions necessary for the electric motor 3 to make, to bring the units into coincidence can be infinitely varied between two limits. It will be appreciated from the foregoing that the angle of correction is different for different elevations.

As a further alternative, in lieu of the mechanical connection for altering the angular displacement between the Selsyn units, a third unit 16 may be interposed, as shown in Figures 4 and 5, the rotor 17 of which is connected with the electric motor 3 through the medium of the cam mechanism, shown in Figure 5, the arrangement being such that rotation of the rotor 17 secured on the shaft 18 of the third unit will effect the position of the rotor 1a of the transmitter Selsyn unit 1 associated with the thermionic amplifier, the position of the rotor 17 of the third unit depending upon the position of the cam follower 6 relative to its associated cam 15 or cams 5.

The position of the cam follower 6 on the cam or cams can be varied manually or in any other suitable manner and may, in fact, be controlled by means of a device actually measuring the muzzle velocity of the gun, or may be moved in accordance with the number of shots fired from the gun. For example, a cam follower may be arranged to be moved gradually along the cam surface or over the cams to automatically correct for lower muzzle velocity resulting from wear in the barrel as wear occurs.

Although the construction of the hydraulic power amplifier forms no part of the present invention, the construction being disclosed in the specification of copending application for patent Serial No. 435,348, filed March 19, 1942, the power amplifier is shown in Figures 2, 3 and 5, the power amplifier 19 being shown in geared connection with the gun 20.

What we claim and desire to secure by Letters Patent of the United States is:

1. Apparatus for automatic adjustment in elevation of a gun, comprising an electric transmitter unit, an electric receiver unit, a controllable power drive device in driving connection with said receiver unit, a gun elevation adjustment mechanism, an operative connection from said device to said mechanism, electric connections between the said transmitter and receiver units and the control of the power drive device for securing correspondence of movement as between the adjustive movements supplied to the transmitter

unit and the output movements of said power drive device, profiled cam means having an input member for its working displacement and an output follower member for receiving correction displacements, a driving connection effectively operating between the input member of said cam means and said power drive device, means effective to transmit adjustive displacements to said elevation adjustment mechanism additional to those adjustive displacements normally supplied to the transmitter, and a connection between the said means for transmitting additional adjustive displacements and the output member of said cam means.

2. Apparatus for automatic adjustment in elevation of a gun comprising an electric transmitter unit, an electric receiver unit, a controllable power drive device in driving connection with said receiver unit, a gun elevation adjustment mechanism, an operative connection from said device to said mechanism, electric connections between the said transmitter and receiver units and the control of the power drive device for securing correspondence of movement as between the adjustive movements supplied to the transmitter unit and the output movements of said power drive device, profiled cam means having an input member for its working displacement and an output follower member for receiving correction displacements, the cam means profile being designed to cause the output follower member to have displacements proportional to elevational muzzle velocity corrections when the input member has imparted to it displacements proportional to gun elevation, a driving connection effectively operating between the input member of said cam means and said power drive device, means effective to transmit adjustive displacements to said elevation adjustment mechanism additional to those adjustive displacements normally supplied to the transmitter, and a connection between said means for transmitting additional adjustive displacements and the output member of said cam means.

3. Apparatus for automatic adjustment in elevation of a gun comprising an electric transmitter unit, an electric receiver unit, a controllable power drive device in driving connection with said receiver unit, a gun elevation adjustment mechanism, an operative connection from said device to said mechanism, electric connections between the said transmitter and receiver units and the control of the power drive device for securing correspondence of movement as between the adjustive movements supplied to the transmitter unit and the output movements of said power device, profiled cam means having several cam surfaces, an input member driving the cam means in its working displacement, an output follower member selectively engaging one of the cam surfaces of said cam means, each such cam surface being designed with an assumed degree of wear in the associated gun barrel so as to produce in the follower member appropriate displacements proportional to elevational muzzle velocity corrections as a function of the elevation of the associated gun, a driving connection effectively operating between the input member of said cam means and said power drive device, means effective to transmit adjustive displacements to said elevation adjustment mechanism additional to those adjustive displacements normally supplied to the transmitter, and a connection between the said means for transmitting additional adjustive displacements and the output member of said cam.

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4. Apparatus for automatic adjustment in elevation of a gun comprising an electric transmitter unit, an electric receiver unit, a controllable power drive device in driving connection with said receiver unit, a gun elevation adjustment mechanism, an operative connection from said device to said mechanism, electric connections between the said transmitter and receiver units and the control of the power drive device for securing correspondence of movement as between the adjustive movements supplied to the transmitter unit and the output movements of said power drive device, a camoid having several different cam profiles making up its cam surface, an input member driving the camoid in its working displacement, an output follower member selectively engaging one of said cam profiles, each cam profile being designed with an assumed degree of wear in the associated gun so as to produce in the follower member displacements proportional to elevational muzzle velocity corrections as a function of the elevation of the associated gun, a driving connection effectively operating between the input member of said camoid and said power drive device, means effective to transmit adjustive displacements to said elevation adjustment mechanism additional to those adjustive displacements normally supplied to the transmitter, and a connection between said means for transmitting additional adjustive displacements and the output member of said camoid.

5. Apparatus for automatic adjustment in elevation of a gun, comprising an electric transmitter unit, an electric receiver unit, a controllable power drive device, a driving connection between said device and said receiver unit, a gun elevation adjustment mechanism, an operative connection from said device to said mechanism, electric connections between said transmitter and receiver units and the control of the power drive device for securing correspondence of movement as between the adjustive movements applied to the transmitter unit and the output movements of said power drive device, profiled cam means having an input member for its working displacement and an output follower member for receiving correction displacements, a driving connection effectively operating between the input member of said cam means and said power drive device, a differential gear interposed in the said driving connection between the receiver unit and power drive device, and a connection from the output member of said cam means to the differential gear.

6. Apparatus for automatic adjustment in

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elevation of a gun, comprising a Selsyn transmitter unit, a Selsyn receiver unit, a controllable power drive device in driving connection with said Selsyn receiver unit, a gun elevation adjustment mechanism, an operative connection from said device to said mechanism, electric connections between said Selsyn units and the control of the power drive device for securing correspondence of movement as between the adjustive movements supplied to the Selsyn transmitter unit and the output movement of said power drive device, profiled cam means having an input member for its working displacement and an output follower member for receiving correction displacements, a driving connection effectively operating between the input member of said cam means and said power drive device, electrical means to transmit adjustive displacements to said elevation adjustment mechanism additional to those adjustive displacements normally supplied to the transmitter and including a rotor and a connection between the output member of said cam means and said rotor.

7. Apparatus for automatic adjustment in elevation of a gun, comprising a Selsyn transmitter unit, a Selsyn receiver unit, a controllable power drive device in driving connection with said Selsyn receiver unit, a gun elevation adjustment mechanism, an operative connection from said device to said mechanism, electric connections between said Selsyn units and the control of the power drive device for securing correspondence of movement as between the adjustive movements supplied to the Selsyn transmitter unit and the output movement of said power drive device, profiled cam means having an input member for its working displacement and an output follower member for receiving correction displacements, a driving connection effectively operating between the input member of said cam means and said power drive device, adjustable electrical phase-displacing means in the connections between the Selsyn units permitting them to operate out of mechanical alignment while being in electrical alignment to an extent corresponding to the adjustment of said adjustable phase-displacing means, and a connection between the output member of said cam means and said adjustable electrical phase-displacing means to permit an out-of-alignment operation depending upon the displacement of said output follower member.

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