

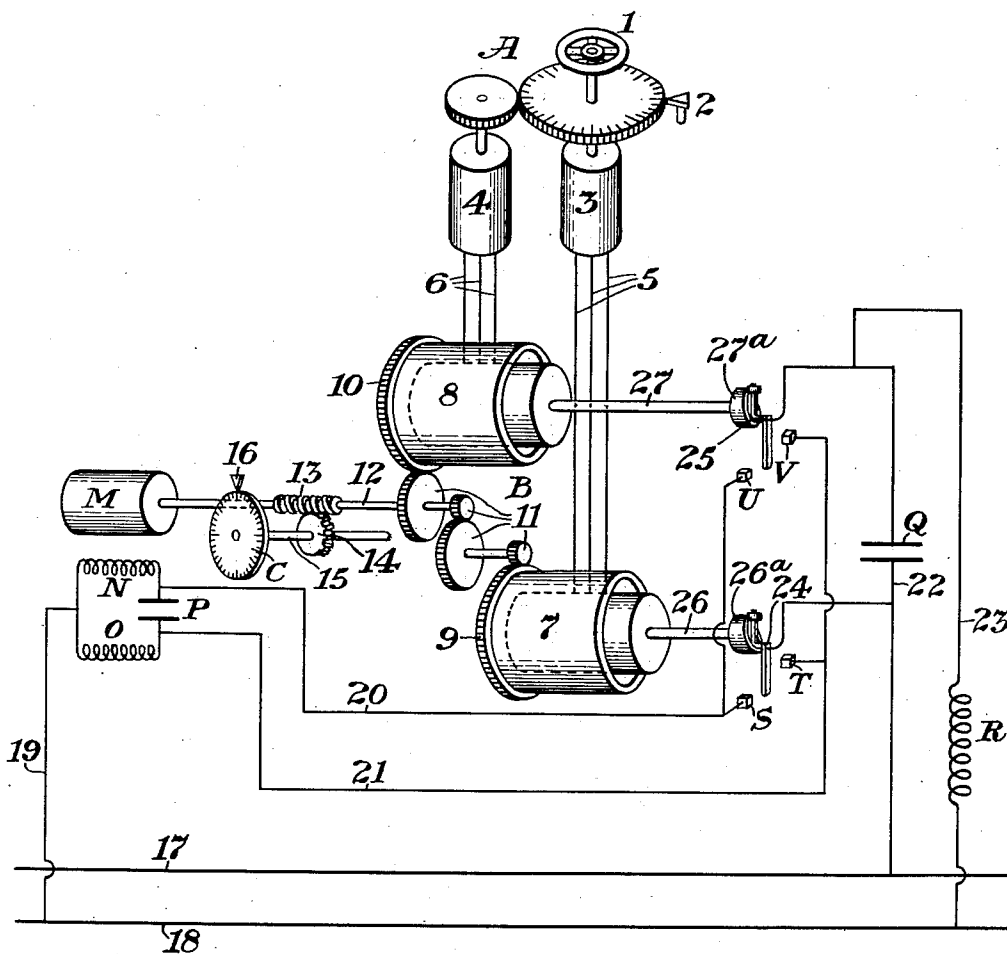
March 19, 1940.

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2,194,170

FOLLOW-UP

Filed Oct. 11, 1938



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2,194,170

FOLLOW-UP

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Application October 11, 1938, Serial No. 234,407

4 Claims. (Cl. 172-239)

This invention relates to a receiver mechanism of the follow-up type and particularly to the type utilized with electrical transmission systems for driving an object in response to movement of a controlling object and accompanied by an amplification of the power applied to the controlled object. More specifically this invention relates to the control of a servo-motor in systems of this type for driving an object in response to the action of dual high and low speed self-synchronous systems.

Where it is desired to transmit angular motions accurately, it is common to use two self-synchronous systems. With one of these systems, the transmitter is operated in a one to one ratio with the controlling object, and the transmitter of the other system is operated in a higher ratio with respect to the controlling object. The receivers of these two systems are thus actuated in accordance with their transmitters and their respective ratios with respect to the controlling object. In systems in which the receivers are arranged to control the operation of a prime mover to effect movement of a driven object in accordance with the movement of the controlled object, the receiver actuated in a ratio of one to one with the driven object takes predominance in the control of the follow-up prime mover, in that it assumes control as soon as the disagreement in position between the driving and driven members exceeds a certain amount. In such systems as have heretofore been used, it has been necessary to utilize complicated relays or mechanical connections between the receivers of the self-synchronous systems or between these receivers and the servo-motor, the energization of which they control.

It is an object of this invention to provide a receiving mechanism by means of which a sensitive control of the driven object can be had throughout the range of movement of the controlling object without resorting to the use of mechanical or electrical relays or transfers of any kind between the control contacts corresponding to the coarse or fine adjustment receivers. The arrangement is of simple construction and has a relatively small number of mechanical elements for actuating the necessary electrical contacts for controlling the servo-motor.

In accordance with the provisions of the invention these objects are accomplished by the use of a capacitor type servo-motor adapted to be operated by a pair of control circuits arranged

to conjointly and independently control the energization of this motor. These circuits are controlled by coarse and fine adjustment receivers so that when both of these receivers are acting conjointly, the motor will be controlled to operate in accordance with the actuation of the coarse adjustment receiver.

The invention together with the objects and advantages thereof will be more fully understood upon reference to the following description and the accompanying drawing of which the single figure shows diagrammatically a position reproducing system embodying the invention.

Referring to the single figure, A designates a transmitting station capable of being adjusted to any desired position with reference to a pointer 2 by means of an adjusting device or handle 1. The transmitting station A consists of transmitters 3 and 4 which may be geared together so that one system, the one including the transmitter 4 makes thirty-six revolutions while the system including the transmitter 3 makes one revolution. The transmitting elements 3 and 4 are connected by wires 5 and 6 to the receivers 7 and 8 respectively, which receivers form a receiving station at B for the transmitting station A. The mechanism so far described consists of two self-synchronous transmission systems of the type well known in the art and their detail description and illustration has been omitted.

When the handle 1 of the transmitter A is moved to a position, with reference to the pointer 2, the transmitters 3 and 4 (referred to hereinafter as the transmitting elements for coarse and fine adjustment respectively) effect in a well known manner rotation of the rotors of the receivers 7 and 8, which will hereinafter be referred to as the receivers for coarse and fine adjustment respectively.

The stators of the receivers 7 and 8 are connected by gears 9 and 10 respectively and a gear train 11 to a shaft 12 carrying a worm gear 13 which is connected by means of a pinion 14 and a shaft 15 to an indicator dial C. The shaft 12 is also rotatably connected to a servo-motor M, of a reversible, capacitor type having coils N and O which are connected to receive electrical energy from line wires 17 and 18, by means of wires 19, 20, 21, 22 and 23. A capacity, or condenser P, is connected across the coils N and O of the motor M. Another condenser Q is connected in series with an inductance R and they are connected in series across the line wires 17 and 18 by means of the wires 22 and 23.

The motor M is controlled by two sets of con-

tacts, each set independently adapted to effect the operation of the motor. One of these sets of contacts comprises a movable contact arm 24, connected to the rotor of the coarse adjustment receiver 7 by means of a shaft 26, and operatively associated with stationary contacts S and T (referred to hereinafter as the coarse contacts). Contacts S and T are connected to wires 20 and 21 respectively, in the circuit of the motor M. The other set of contacts includes another movable contact arm 25, connected to the rotor of the fine adjustment receiver 8 by means of a shaft 27, and operatively associated with stationary contacts U and V (referred to hereinafter as the fine contacts). Contacts U and V are connected to the wires 20 and 21 respectively in the circuit of the motor M.

When the receivers for the coarse and fine adjustment are operating conjointly to control the operation of the motor M, the condenser Q, connected in series with the contact arm 25, causes the motor M to operate in accordance with the actuation of the coarse adjustment receiver.

The movable contact arms 24 and 25 are coupled to the outer ends of the shafts 26 and 27 respectively by means of yieldable cam couplings 26a and 27a, by means of which these arms are kept in proper relation with their appropriate contacts during each half revolution of their respective rotors. Such a coupling permits relative movement of the rotor and the contact arm connected thereto, but reverses the contact arm every half revolution of such relative movement. By this means the motor is controlled to drive the driven object by the most direct path into positional agreement with the controlling object. This yieldable coupling is particularly desirable when both coarse and fine adjustment receivers are used, since it permits relative motion between the rotor and contact arm of the fine adjustment receiver during the period in which the servo-motor operates under the control of the coarse receiver.

In operation of the system when the transmitter A is moved by means of the handle 1 to a new position, with reference to the pointer 2, the rotors of the receivers 7 and 8 will follow this movement in accordance with their respective ratios with respect to the handle 1. The contact arms 24 and 25 are thus moved to effect energization of the motor M by completing the circuit to the motor. The rotation of the motor M, its shaft 12 and worm 13 drives pinion 14 and load shaft 15 and incidentally turns the indicator dial C to a point with reference to the pointer 16 which is in positional agreement with that of the dial of the transmitter A. At the same time the motor M also drives the stators of the receivers 7 and 8, through the gear train 11 and gears 9 and 10 respectively, in directions opposite to the movements of their rotors, whereby the rotors are restored to their original angular position between the contacts.

Assume, for example, that the handle 1 of the transmitter A is moved to a new position with reference to the pointer 2 corresponding to a small angular movement of say, several degrees, in a direction so that the fine contact arm 25 will make connection with the fine contact V. A control circuit is thereby closed from this contact as follows: Line wire 17, wire 22, condenser Q, contact arm 25, contact V, wire 21, coil O (and condenser P and coil N), wire 19 to line wire 18. This will cause the motor M to operate in one direction. For an equal angular movement of

the handle 1 of the transmitter A in the opposite direction, the rotation of the motor M will be reversed, since the contact arm 25 will make connection with the opposite fine contact U.

For a larger angular movement of the transmitter A, corresponding to a movement of say, 100 degrees in such a direction that the arm 24 makes the coarse contact T, a control circuit is thereby closed from this contact as follows: Line wire 17, wire 22, contact arm 24, contact T, wire 21, motor coil O (and condenser P and coil N) and wire 19 to line wire 18. The receiver 7 will be driving and the contact arm 25 of the fine receiver will be moving back and forth with each 5° of travel (assuming a ratio of 36 to 1 in the gears between the fine and coarse transmitters), making contact alternately on fine contacts U and V. When the contact is made on fine contact U, the condensers Q and P are connected in parallel, putting the sum of their capacities in the supply to the motor M. When the contact is made on the fine contact V, the condenser Q is paralleled and has no effect.

While the use of the condenser Q in the circuit described above provides a satisfactory system, the addition of the inductance R, in proper value and connected in as illustrated, results in a better operation over a greater range of conditions, and particularly is this true when the coarse and fine contacts are operating on opposite sides of the motor. The general purpose of inductance R is to increase the inductance in proportion to the increase of capacity by the inclusion of capacity Q.

From the foregoing description it will be apparent that a reproducing system is provided by means of which a sensitive control of the driven object is had throughout the total range of movement of the controlling object. The mechanism is simple of construction, and has but a few mechanical elements for controlling the servo-motor. The foregoing is accomplished by the elimination of electrical or mechanical transfers between the coarse and fine contacts.

While a preferred embodiment of the invention has been shown and described, it will be understood that the invention may be embodied in other forms and that various changes may be made in the structural details without departing from its principles as defined in the appended claims.

I claim:

1. An electrical system for reproducing angular position comprising a coarse adjustment transmitter and receiver and a fine adjustment transmitter and receiver, a follow-up motor of the single phase, alternating current capacitor type, a motor circuit, two pairs of contacts connected in parallel in the motor circuit, a cooperative contact for each pair of contacts controlled by one of the receivers, and a separate capacity in circuit with one of the cooperative contacts.
2. An electric system for reproducing angular position comprising in combination, a transmitting element for fine adjustment, a transmitting element for coarse adjustment, corresponding receiver elements respectively connected to said transmitting elements, a reversible capacitor type electrical motor, a pair of control means, each independently operative to effect the operation of the motor including a pair of electrical circuits each comprising relatively movable contacts for controlling the energization thereof, a connection for effecting the relative movement of the contacts of one circuit by the fine adjustment

receiver, a connection for effecting the relative movement of the contacts of the other circuit by the coarse adjustment receiver, and a condenser in one of said circuits for causing the motor to operate in accordance with the coarse adjustment receiver upon conjoint energization of the said circuits.

3. An electric system for reproducing angular position comprising in combination, a transmitting element for fine adjustment, a transmitting element for coarse adjustment, corresponding receiver elements respectively connected to said transmitting elements, a reversible capacitor type electrical motor, a pair of control means, each independently operative to effect the operation of the motor including a pair of electrical circuits each comprising relatively movable contacts for controlling the energization thereof, a connection for effecting the relative movement of the contacts of one circuit by the fine adjustment receiver, a connection for effecting the relative movement of the contacts of the other circuit by the coarse adjustment receiver, and a condenser and a reactance for causing the motor to operate in accordance with the coarse adjustment receiver upon conjoint energization of the said circuits.

4. An electrical system for reproducing angular position comprising in combination, a transmitting element for fine adjustment, a transmitting element for coarse adjustment, corresponding receiver elements respectively connected to said transmitting elements, a reversible capacitor type electric motor, a pair of control means each independently operable to effect the operation of the motor and including relatively movable contacts, a connection for effecting relative movement of the contacts of one control means by the relative angular position of the fine adjustment receiver and the motor, a connection for effecting relative movement of the contacts of the other control means by the relative angular position of the coarse adjustment receiver and the motor, and a condenser in circuit with the contacts of the control means operated by the fine adjustment receiver for causing the motor to operate in accordance with the coarse adjustment receiver upon conjoint energization of the two control means.

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