

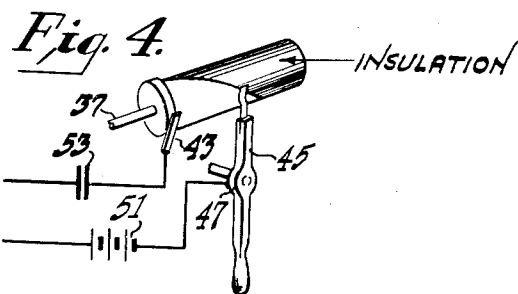
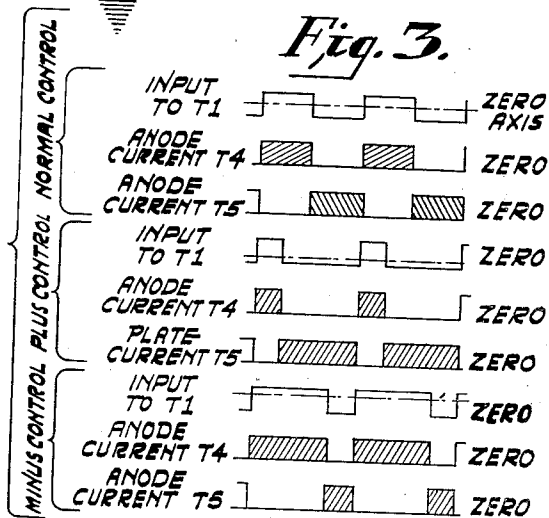
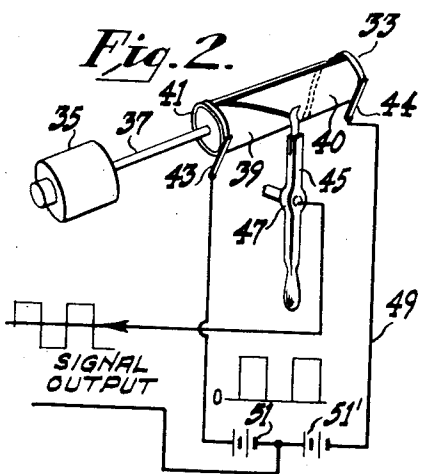
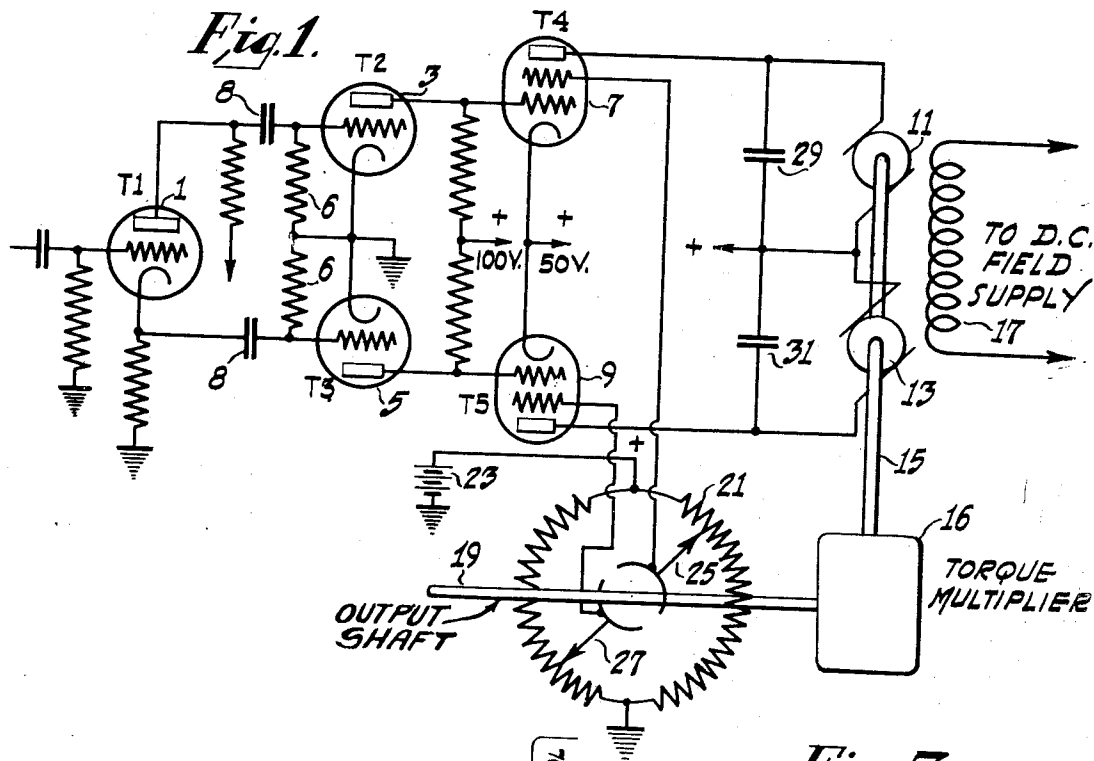
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REMOTE CONTROL CIRCUIT

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REMOTE CONTROL CIRCUIT

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This invention relates to remote control systems, and more particularly to an improved method of and means for controlling the position of a movable object by means of electrical signals. Frequently the control signal channel for such a system includes a radio link or other transmission means subject to interference from external sources, which may derange the operation of the system, causing false response or failure.

Accordingly, it is the principal object of the present invention to provide an improved method of and means for remote control, avoiding to a large extent the deleterious effects of interference with the control signals.

Another object is to provide a method of and means for utilizing pulse signals for remote control.

A further object is to utilize said pulse signals so as to respond to the timing, rather than to the amplitudes or wave shapes of the pulses.

These and other objects will become apparent to those skilled in the art upon consideration of the following description, with reference to the accompanying drawing, of which Fig. 1 is a schematic diagram of receiver system embodying the invention, Fig. 2 is a schematic diagram of a system for generating control signals of the type used in the practice of the invention, Fig. 3 is a group of graphical representations of wave shapes of the voltages occurring at various points in the circuit during operation, and Fig. 4 is a modified transmitter system.

It has been found that in the control of television receivers, by means of pulse signals, the effects of interference are minimized by virtue of the fact that the essence of the control signals lies in their timing, rather than in their amplitude or exact wave shape. This effect is taken advantage of in the system described below, in that control is accomplished by varying the durations of alternate positive and negative pulses.

Referring first to Fig. 3, the "normal" condition is that in which the net torque output of the system is zero. The control signal input is a square wave having positive and negative loops of equal time duration. Under "plus control" the net torque is positive, clockwise, for example. The corresponding control signal input is a wave with positive loops of less duration than the negative loops. Conversely, the signal for "minus control," or counterclockwise torque, has positive loops of greater duration than the negative loops.

Referring to Fig. 1, a tube 1, is connected as a phase inverter. The output of the phase inverter

is applied in push-pull to a pair of tubes 3 and 5 which are connected as amplifiers and are coupled directly to the control grids of a pair of power tubes 7 and 9. The tubes 3 and 5 are self biased by the grid leaks 6 and capacitors 8. The anode circuits of the power tubes 7 and 9 are connected to direct current motor armatures 11 and 13 which are mounted on a single shaft 15 and are provided with a common field winding 17. The two armatures are connected in bucking relation to each other, so that the anode current of the tube 7 tends to produce rotation of the shaft 15 in the opposite direction to that produced by the anode current in the tube 9. The shaft 15 is mechanically connected to a control shaft 19 which provides the mechanical output of the system. The connection between the shafts 15 and 19 may include a torque amplifier 16, of any conventional design. A double potentiometer 21 is connected in a bridge circuit across a D.-C. source 23. The moveable arms 25 and 27 are mechanically connected to the shaft 19 and electrically connected to the screen grids of the tubes 7 and 9 respectively. The armatures 11 and 13 are shunted by a pair of capacitors 29 and 31 respectively.

The operation of the system of Fig. 1 is as follows:

With a signal input such as that designated as "normal" in Fig. 3, the outputs of the tube 1 comprise rectangular waves of equal durations and opposite polarities. The bias at the grids of the tubes 3 and 5 is set substantially at the input voltage peaks, due to charging of the coupling capacitors by grid current on the positive swings and discharges of the coupling capacitors through the grid leaks on the negative swings. Thus the positive pulse loops are amplified by the tube 5, and the negative loops by the tube 3, providing similar voltage pulses on the grids of the tubes 7 and 9. These pulses are of sufficient amplitude to cut off the anode currents on the negative swings, so that the tubes 7 and 9 are alternately conductive during equal periods as illustrated by conditions shown in Fig. 3. When the input signal comprises positive pulses of shorter durations than the negative pulses as illustrated by the "pulse" control of Fig. 3, the periods during which the tube 7 is conductive are shorter than those during which the tube 9 conducts. The average current through the armature winding 11 is thus less than the average current through the armature 13 and the motor shaft 15 is rotated in a clockwise direction. The capacitors 29 and 31 serve to smooth out the pulses of the anode cur-

rents into comparatively steady direct currents through the armatures. The rotation of the shaft 15 and with it the shaft 19 operates the potentiometer 21 to increase the screen grid voltage on the tube 7 simultaneously decreasing the voltage on the screen of the tube 9. This increases the amplitudes of the pulses in the output of the tube 7 and decreases the output of the tube 9. This operation continues until the average currents through the two armatures are equal, whereupon the net torque on the shaft 15 becomes zero. This condition is maintained as long as the input signal remains unchanged. The operation of this system under the "minus" control conditions is identical with that described above, but in the opposite direction, with the pulses in the output of the tube 9 of longer duration than those of the output of the tube 7. This is shown by the "minus" control conditions illustrated in Fig. 3.

Fig. 2 illustrates a system for generating control signals of the type shown in Fig. 3. A cylindrical drum 33 of insulating material is connected to a motor 35 through a shaft 37. Each half of the surface of the drum 33 is covered by a triangular sheet of conductive material wrapped around the drum. A slip ring 41 is provided at one end of the drum 33 and is connected to or constructed integrally with the sheet 39. A second slip ring 42 at the other end is connected to the sheet 40. Brushes 43 and 44 are supported in engagement with the slip rings 41 and 42 respectively. A contact 45 is supported on the pivot 47 and connected to a control lever 48. Direct current sources 51 are connected to the brushes 43 and 44 in opposite polarities and to one side of the signal output circuit. The contact 45 is connected to the other side of the output circuit. The operation of the signal generating device of Fig. 2 is as follows:

As the drum 33 is rotated continuously by the motor 35, the contact 45 engages the sheets 39 and 40, providing alternate positive and negative pulses in the signal output circuit.

The ratio of the positive pulse duration time to the negative pulse duration time is a function of the position of the contact 45 with respect to the drum 43. If the contact 45 is moved toward its right hand position, the negative pulses applied to the signal output circuit have a duration time longer than that of the positive pulses as illustrated under the "plus" control condition in Fig. 3. Similarly, if the contact 45 is moved toward the left "minus" control signals are produced.

Fig. 4 illustrates a modified signal generator device comprising a drum 33 similar to that of Fig. 2 provided with a single triangular sheet 39 covering one half of its surface. A single D.-C. source 51 is switched on and off during rotation of the drum 33, the ratio of the on period to the off period being a function of the position of the control lever. A capacitor 53 may be provided in the signal output circuit. This shifts the zero axis of the signal to a point between the upper and lower loops of the wave, providing signals like those illustrated in Fig. 3. The capacitor 53 may be omitted if a receiver system like that illustrated in Fig. 1 is used, since the coupling capacitors 8 between the phase inverter 1 and the tubes 3 and 5 will provide the same effect.

Thus the invention has been described as an improved remote control system employing pulse signals of variable duration times to achieve freedom from the effects of interference. One embodiment of the invention has been described

including a motor with a double armature winding energized through negative peak limiting amplifiers and driving a double potentiometer to balance the energization of the two armatures by differentially controlling the gains of the amplifiers. In some instances, it may be desirable to substitute equivalent means for practicing the invention, such as, for example, a motor provided with two fields and a single armature. It is also to be noted that the follow-up connection, comprising the potentiometer 21 and the associated circuits, may be omitted. Then the motor will be energized to provide a torque corresponding in magnitude and direction to the position of the controller, instead of running to some corresponding position and stopping.

I claim as my invention:

1. The method of operating an electric motor in response to variation in the position of a control device comprising the steps of deriving a voltage of rectangular wave form with positive loops related in duration time to the negative loops of said wave as a function of the position of said control member, deriving from said voltage a second voltage inverted in polarity with respect to said first voltage, energizing said motor to produce torque in one direction in response to said first voltage and energizing said motor to produce torque in the opposite direction in response to said second voltage, whereby said motor produces an average torque related to the difference between the duration times of said positive loops and the duration times of said negative loops.

2. The method of controlling an electric motor comprising the steps of producing a control signal comprising a wave of substantially constant repetition period and variable duration period, deriving therefrom a second signal similar to said control signal but inverted in polarity, cutting off the negative loops and integrating the positive loops of both of said signals, energizing said motor to produce torque in one direction in response to the first of said integrated signals, and energizing said motor to produce torque in the opposite direction in response to the second of said integrated signals.

3. The method of controlling a motor in response to variations in the position of a control device including the steps of deriving a control signal comprising impulses of constant repetition period and of duration period variable in response to the position of said control device, deriving from said control signal a second signal similar to said control signal but inverted in polarity, cutting off the negative loops of both of said signals, amplifying the positive loops of said signals separately, integrating said amplified signals, energizing said motor to produce torque in one direction in response to one of said amplified and integrated signals, simultaneously energizing said motor to produce torque in the opposite direction in response to the other of said amplified and integrated signals, and differentially varying the amplification of said signals in response to the angular position of the shaft of said motor.

4. A remote control system including an electric motor provided with differentially operative power input circuits, amplifiers connected to supply power to each of said circuits respectively, said amplifiers being biased to conduct only in response to positive signal impulses and to cut off in response to negative signal impulses, a signal input circuit, phase inverter means connected

between said signal input circuit and the input circuits of said amplifiers, and means for differentially varying the gains of said amplifiers in response to the angular position of the output shaft of said motor.

5. A system for operating an electric motor in response to variation in the position of a control device, including means for producing an alternating voltage wave with positive loops related in duration time to the negative loops of said 10

5 wave as a predetermined function of the position of said control member, amplifiers connected to supply power to said motor so as to produce torque in respectively opposite directions of rotation, means for applying said voltage wave in one polarity to the input circuit of one of said amplifiers in the opposite polarity to the input circuit of the other of said amplifiers.

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