June 7, 1949. W. JONES 2,472,535

ELECTRIC REMOTE-CONTROL OR INDICATING SYSTEM

Filed Aug. 15, 1944

FIG. 1.

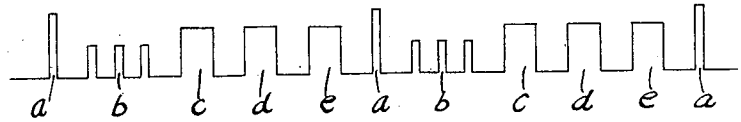


FIG. 2.

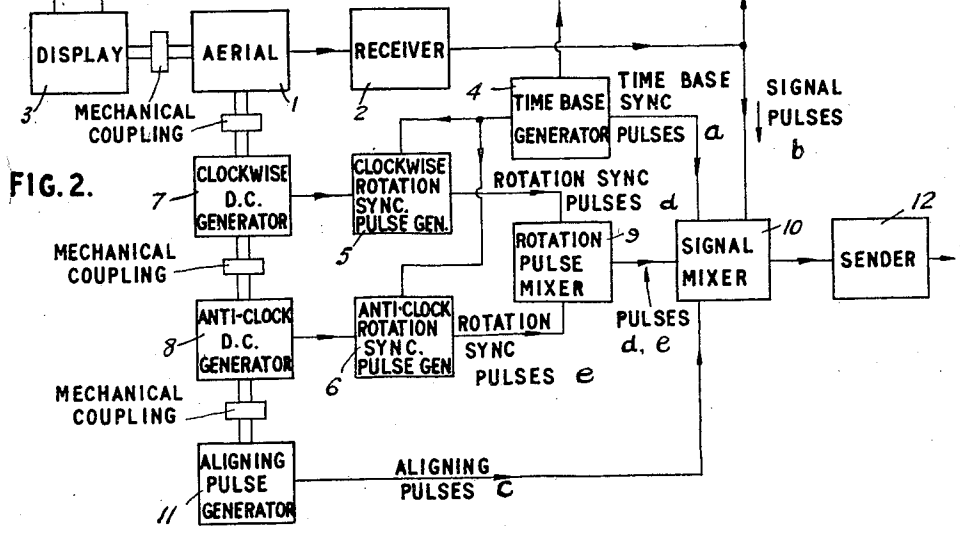
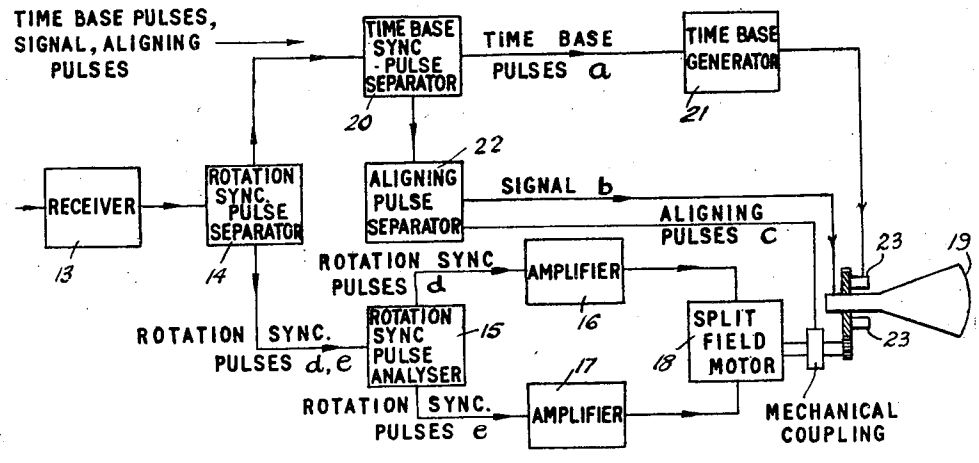


FIG. 3.



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ELECTRIC REMOTE-CONTROL OR INDICATING SYSTEM

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11 Claims. (Cl. 343—118)

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The present invention relates to electric remote control or indicating systems for transmitting mechanical or electrical movements to a distance.

In British patent specification No. 577,795 of William Jones and Pye Limited, a remote control or indicating system is described in which the movement of a mechanically rotating directional radio aerial system is transmitted to a remote point over a radio or cable link. In that system the aerial system rotates continuously at a given rate in one direction.

The present invention has for its object to provide a remote control or indicating system in which movements in any direction and at any speed, and which may be started or stopped at will, may be correspondingly reproduced at the remote station, the transmission being effected over a radio link, cable or otherwise. A further object of the invention is to provide an arrangement which also permits other intelligence or information, which may vary with the position of the moving device, to be simultaneously transmitted to the remote station over the same carrier wave or other communication channel.

The information to be conveyed may be that contained on or reproducible upon the screen of a cathode ray tube, the beam of which is caused to scan radially from the centre of the tube, the scan also being caused to revolve or swing about the centre of the tube in synchronism with some form of directional device, for example an aerial giving azimuth bearing, and a further object of the invention is to provide a system for reproducing at the remote station the scan on the cathode ray tube with the information contained therein.

The present invention consists, broadly, in transmitting impulses over the radio link, cable or other communication channel which are modulated in width, height or in any other suitable manner or combination in dependence upon the direction and speed of the movement to be reproduced at the remote station, and are employed at the remote station to control the operation of the reproducing apparatus. Modulated pulses may be employed in conjunction with unmodulated pulses as a reference datum to establish a modulation differential the magnitude of which indicates the speed and the sign of which indicates the direction of the movement to be reproduced. A feature of the invention, therefore, consists in transmitting two series of pulses which are modulated in dependence

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upon the movement to be reproduced, the difference in modulation between the two series of pulses being employed at the remote station to control the operation of the reproducing apparatus. Thus, if pairs of impulses are transmitted which are modulated, for example, in width, the movement or rotation to be reproduced is caused to modulate the pulses so that the width of one is greater than that of the other for one direction of the movement or rotation, while movement or rotation in the opposite direction makes the width of the second pulse greater than that of the first. The speed of movement or rotation in either direction is indicated by the degree or magnitude of the difference in width between the pairs of pulses.

By transmitting the movement or rotation synchronising signal as pulses, there may be also simultaneously transmitted over the same carrier wave or channel other pulses conveying the information to be transmitted, as well as time base synchronising pulses and also marker or aligning pulses such as are described in the British patent specification No. 577,796 of Leslie Walter Germany and Pye Limited.

The invention will be more clearly understood from the following description of one embodiment thereof with reference to the accompanying drawings, in which

Fig. 1 is a diagram depicting the waveform transmitted from the sending to the receiving station, and

Figs. 2 and 3 are schematic circuit diagrams of the sending and receiving stations respectively.

The application of the invention about to be described is to a radiolocation or like system in which information received at a sending station is to be reproduced at a remote receiving station. It is assumed that the information to be transmitted is that contained or to be indicated on the screen of a cathode ray tube at the sending station, the beam of which is caused to scan radially from the centre of the tube whilst the scan is also caused to revolve or swing about the centre of the tube in synchronism with the movement of some form of rotatable or swinging directional device such as a radio aerial giving azimuth bearing. By embodying the present invention, the system permits the aerial to be rotated in either direction, at any speed, and stopped and started at will, while under these varied conditions reproducing on a duplicate cathode ray tube at the receiving station the scan on the cathode ray tube at

the sending station with the information contained therein.

This is effected by a pulse transmission utilising the waveform depicted in Fig. 1 in which the pulses *a* represent time base synchronising pulses for synchronising the radial scan of the cathode ray tube at the receiving station, the pulses *b* represent signal pulses containing the information to be conveyed, the pulses *c* represent marker or aligning pulses, and the pairs of pulses *d* and *e* represent the rotation synchronising pulses provided in accordance with this invention for causing the rotating or swinging scan at the receiving station to follow the movement of the aerial at the sending station. The pulses *c*, *d* and *e* are contained within the black-out or fly-back period of the radial scan.

The marker pulses *c* occur only at a given azimuth bearing, for example due north for a period representing approximately 5°, and these marker pulses are employed for angularly aligning the scan on the cathode ray tube at the receiving station with the aerial at the sending station, the manner in which this is achieved being more fully described in the aforesaid British specification No. 577,796.

At the sending station depicted in Fig. 2, the pulses *b* containing the information to be conveyed are derived from the signals picked up by the rotating directional aerial 1 and detected and amplified by the receiver 2, the signal output of the receiver 2 being also fed to and reproduced in the cathode ray tube 3 of the local display device. The rotating field of the tube 3 may be produced by mechanically coupling the aerial 1, if desired through a Selsyn drive, with the deflecting coils of the tube 3. The time base synchronising pulses *a* are developed from the sending time base generator 4, which also controls the radial scan of the cathode ray tube 3.

The present invention is more particularly concerned with the generation and application of the rotation synchronising pulses *d* and *e*. These pulses are width modulated in the present embodiment and are generated respectively by the two pulse generators 5 and 6, controlled by the time base generator 4. Two D. C. generators 7 and 8 are mechanically coupled to the aerial 1, the generator 7 functioning when the aerial rotates clockwise and the generator 8 functioning when the aerial rotates anti-clockwise. The generators 7and 8 are of a type giving a D. C. output voltage proportional to their speed of rotation, and the outputs of these generators are fed to the pulse generators 5 and 6 respectively, so as to control the width of the generated pulses in accordance with the speed of rotation of the D. C. generators, and thus in accordance with the speed of rotation of the aerial 1. The two pulse generators 5 and 6 develop the pulses *d* and *e* at all times, whether the aerial is rotating or stationary. When the aerial is stationary, and therefore neither of the D. C. generators 7 and 8 is operative, the pulse generators 5 and 6 develop pulses *d* and *e* of equal width. Under this condition, no D. C. voltage is applied from either D. C. generator to either pulse generator; in other words, both pulse generators are unmodulated. When the aerial 1 is rotated in one direction, one of the D. C. generators 7 and 8 will be operated and its D. C. output voltage fed to its associated pulse generator, modulating the latter to vary the width of the generated pulses, while the other D. C. generator will remain inoperative so that its associated pulse generator remains unmodulated, thus continuing to develop the same width pulses as when the aerial is stationary, this series of pulses serving as reference pulses for determining the pulse width difference indicating the speed of rotation of the aerial. When the aerial rotation is reversed, the functions of the pulse generators are correspondingly reversed. Thus, upon clockwise rotation of the aerial 1, the pulses *d* will be modulated in width, whereas the pulses *e* remain of the same width as when the aerial is stationary; and vice versa upon anti-clockwise rotation of the aerial. Thus, the degree of magnitude of the difference in width between pairs of the pulses *d* and *e* indicates the speed of rotation of the aerial 1. The direction of rotation is indicated by whether *d* is greater than *e* or *e* is greater than *d*; or in other words, adopting the sign convention, the direction is indicated by the sign of the width difference, say *d*—*e*. When the pulses *d* and *e* are equal in width, this means that neither pulse generator is being modulated, neither D. C. generator is functioning, and that the aerial is stationary.

The pulses *d* and *e* from the generators 5 and 6 are mixed together in the mixer 9, the output of which is mixed with the time base synchronising pulses *a* and signal pulses *b* in the mixer 10. An aligning pulse generator 11 is also mechanically coupled to the aerial 1 so as to function when the aerial rotates in either direction, for generating the marker or aligning pulses *c* which are also fed to the mixer 10. The mixed output from the latter is fed to the sender 12 and is transmitted over a radio or cable link to the remote station. If the transmission is over a radio link the sender 12 comprises a radio transmitter which is modulated by the mixed waveform to be transmitted.

At the remote receiving station depicted in Fig. 3, the transmitted signal is received by the receiver 13 which demodulates and amplifies the transmitted signal in the case of a transmission over a radio link, or may comprise a simple amplifier in the case where the transmission has been made by cable. The output from the receiver 13 is fed to a separator 14 where the rotation synchronising pulses *d* and *e* are separated out together and are fed to the analyser 15 where the pulses *d* and *e* are separated from each other and then fed respectively to two amplifiers 16, 17 where the pulses are integrated and converted to D. C. voltages. Each of the amplifiers 16, 17, feeds one half of the field of a split field D. C. motor 18, so that the D. C. voltage developed from the pulses *d* is applied to the motor in opposition to the D. C. voltage developed from the pulses *e*. The motor 18 is mechanically coupled with the deflecting coils 23 of a cathode ray tube 19 to produce a rotating field for rotating the scan of the tube 19.

When the pulses *d* and *e* are equal in width, thus signifying that the aerial 1 at the sending station is stationary, equal voltages are applied by the amplifiers 16 and 17 to the motor 18 and hence it does not rotate and, therefore, the scan of the tube 19 is also not rotated. When the pulses *d* and *e* are unequal in width, unequal voltages are applied to the motor 18 causing it to rotate owing to the development of a resultant field in the motor. The direction in which the motor rotates will clearly depend upon which pulses have the greater width, and the speed of rotation in the determined direction will depend upon the strength of the resultant field in the

motor which, in turn, depends upon the magnitude or degree of the difference in width between the pulses. Consequently, the scan of the tube 19 will be caused to rotate in the direction and at the speed of rotation of the aerial 1 at the sending station.

Following the separation of pulses *d* and *e* in the separator 14 the signal is fed to a separator 20 for the time base synchronising pulses which are then fed to the time base generator 21 which controls the radial scan of the tube 19, so as to synchronise this radial time base scan with the time base at the sending station. The signal pulses *b* and aligning pulses *c* are separated from each other in a separator 22, the pulses *b* being applied as intensity or amplitude modulation to the modulating electrode of the cathode ray tube 19. The aligning pulses *c* are utilised to control the mechanical coupling between the motor 18 and the deflecting coils 23 of tube 19, in the manner more fully described in the aforesaid British specification No. 577,796, for ensuring the angular alignment of the rotation scan with the rotating aerial 1.

Although a particular embodiment of the invention has been described by way of example, it will be understood that various modifications may be made without departing from the invention.

I claim:

1. In an electric remote control system for reproducing motion at a distance, the combination of a moving device capable of movement in opposite directions and at variable speed, and means for producing two series of pulse signals of the same sign with the pulses of the two series differentially modulated in response to the direction and the speed of the movement of said device, for transmission to a remote station to control apparatus thereat for reproducing the movement of said device.

2. In a remote control system for reproducing motion at a distance, including the combination of a device capable of movement in opposite directions and at variable speed, means for generating two series of pulse control signals for transmission to a remote station to control apparatus thereat for reproducing the movement of said device, and means responsive to the movement of said device for selectively modulating as a function of the speed of movement of said device either the one or the other series of pulses according to the direction of movement of said device, whereby the series of pulses not being modulated at the time serves as reference datum to establish a modulation differential between said two series of pulses the magnitude of which indicates the speed and the sign of which indicates the direction of movement of said device.

3. In an electric remote control system for reproducing motion at a distance, the combination of a moving device capable of movement in opposite directions and at variable speed, a station remote from said device, means associated with said device for producing rectangular pulse signals of the same sign differentially modulated in duration time in dependence upon the speed and the direction of the movement of said device, for transmission to said remote station, a movable reproducing device at said remote station and means at said remote station for controlling said reproducing device in response to the pulse modulation differential to cause said reproducing device to execute a duplicate of the movement of said first-mentioned device.

4. In a remote control system the combination of a device capable of movement in opposite directions and at variable speed, a station remote from said device, means associated with said device for generating two series of pulse control signals of the same sign for transmission to said remote station, means responsive to the movement of said device for selectively modulating in duration time as a function of the speed of movement of said device either the one or the other series of pulses according to the direction of movement of said device to establish a modulation differential between the modulated series and the unmodulated series, the magnitude of which indicates the speed and the sign of which indicates the direction of movement of said device, a movable reproducing device at said remote station, and means at said remote station responsive to said two series of pulses respectively for differentially controlling said reproducing device to cause it to execute a duplicate of the movement of said first-mentioned device.

5. A remote control system including a device rotatable in opposite directions and at variable speed, a station remote from said device, means associated with said device for generating two series of pulse control signals for transmission to said remote station, means responsive to the rotation of said device for selectively modulating as a function of the speed of rotation of said device either the one or the other series of pulses according to the direction of rotation of said device to establish a modulation differential between the modulated and unmodulated series, the magnitude of which indicates the speed and the sign of which indicates the direction of said rotation, a reversible motor at said remote station, and means at said remote station for simultaneously energising said motor in opposite directions of rotation in response to said two series of pulses respectively.

6. In combination, a rotatable directional radio aerial, a station remote from said aerial, means associated with said aerial for producing pulse control signals differentially modulated in response to both the direction and the speed of rotation of said aerial, for transmission to said remote station, a cathode ray tube at said remote station, and means at said remote station responsive to said pulses for producing in said tube a rotating electro-magnetic field duplicating the rotation of said aerial.

7. In a system for operating a remote rotatable device in synchronism with a rotatable and reversible directional radio aerial, the combination with said aerial of a pair of pulse signal generators to produce two series of pulse control signals for transmission to said remote device, and a pair of modulating voltage generators associated with said pulse generators respectively and coupled with said aerial so as to be selectively driven according to the direction of rotation of said aerial to produce a voltage for modulating the one or the other series of pulse signals produced by said pulse generators in accordance with the speed of rotation of said aerial.

8. In combination, a reversible rotatable directional radio aerial, a station remote from said aerial, a pair of pulse signal generators for generating two series of pulse control signals for transmission to said remote station, a pair of modulating voltage generators for modulating said pulse generators respectively, said modulat-

ing generators being coupled with said aerial for selective operation according to the direction of rotation of said aerial to produce a voltage related to the speed of rotation of said aerial for modulating the series of pulses produced by the pulse generator associated with the operative modulating generator, a cathode ray tube having rotatable deflecting coils at said remote station, a reversible motor for driving said coils, means for energising said motor to rotate in one direction in response to one of said series of pulses, and means for simultaneously energising said motor to rotate in the opposite direction in response to the other of said series of pulses, whereby to produce a resultant rotation of said motor and said coils which reproduces the rotation of said aerial.

9. In combination, a reversible rotatable directional radio aerial, a station remote from said aerial, a pair of pulse signal generators for generating two series of pulse control signals for transmission to said remote station, a pair of modulating voltage generators for modulating said pulse generators respectively, said modulating generators being coupled with said aerial for selective operation according to the direction of rotation of said aerial to produce a voltage related to the speed of rotation of said aerial for modulating the series of pulses produced by the pulse generator associated with the operative modulating generator, a cathode ray tube having rotatable deflecting coils at said remote station, a reversible motor for driving said coils, means to amplify and integrate the pulses of each of said series separately, and means to apply said amplified and integrated signals to said motor simultaneously and in opposition, whereby to produce a resultant rotation of said motor and said coils which reproduces the rotation of said aerial.

10. In a system for operating a remote rotatable device in synchronism with a rotatable and reversible directional radio aerial, the combination with said aerial of a pair of pulse signal generators to produce two series of pulse control signals for transmission to said remote device, and a pair of modulating voltage generators associated with said pulse generators respectively and coupled with said aerial so as to be selectively driven according to the direction of rotation of said aerial to produce a voltage for modulating the one or the other series of pulse signals produced by said pulse generators in accordance with the speed of rotation of said aerial, and means to transmit further pulse signals cyclically with said pulse series during fractions of the cycle period between successive pulses of said series.

11. In combination, a reversible rotatable directional radio receiving aerial, a station remote from said aerial, a pair of pulse signal generators for generating two series of pulse control signals for transmission to said remote station, a pair of modulating voltage generators for modulating said pulse generators respectively, said modulating generators being coupled with said aerial for selective operation according to the direction of rotation of said aerial to produce a voltage related to the speed of rotation of said aerial for modulating the series of pulses produced by the pulse generator associated with the operative modulating generator, means to derive intelligence pulse signals from said aerial, means to transmit said intelligence pulses cyclically with said series of pulses during fractions of the cycle period between successive pulses of said series, a cathode ray tube at said remote station for indicating the transmitted intelligence in response to said intelligence pulses, rotatable deflecting coils for said tube, a reversible motor for driving said coils, means for energising said motor to rotate in one direction in response to one of said series of pulses, and means for simultaneously energising said motor to rotate in the opposite direction in response to the other of said series of pulses, whereby to produce a resultant rotation of said motor and said coils which reproduces the rotation of said aerial.

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