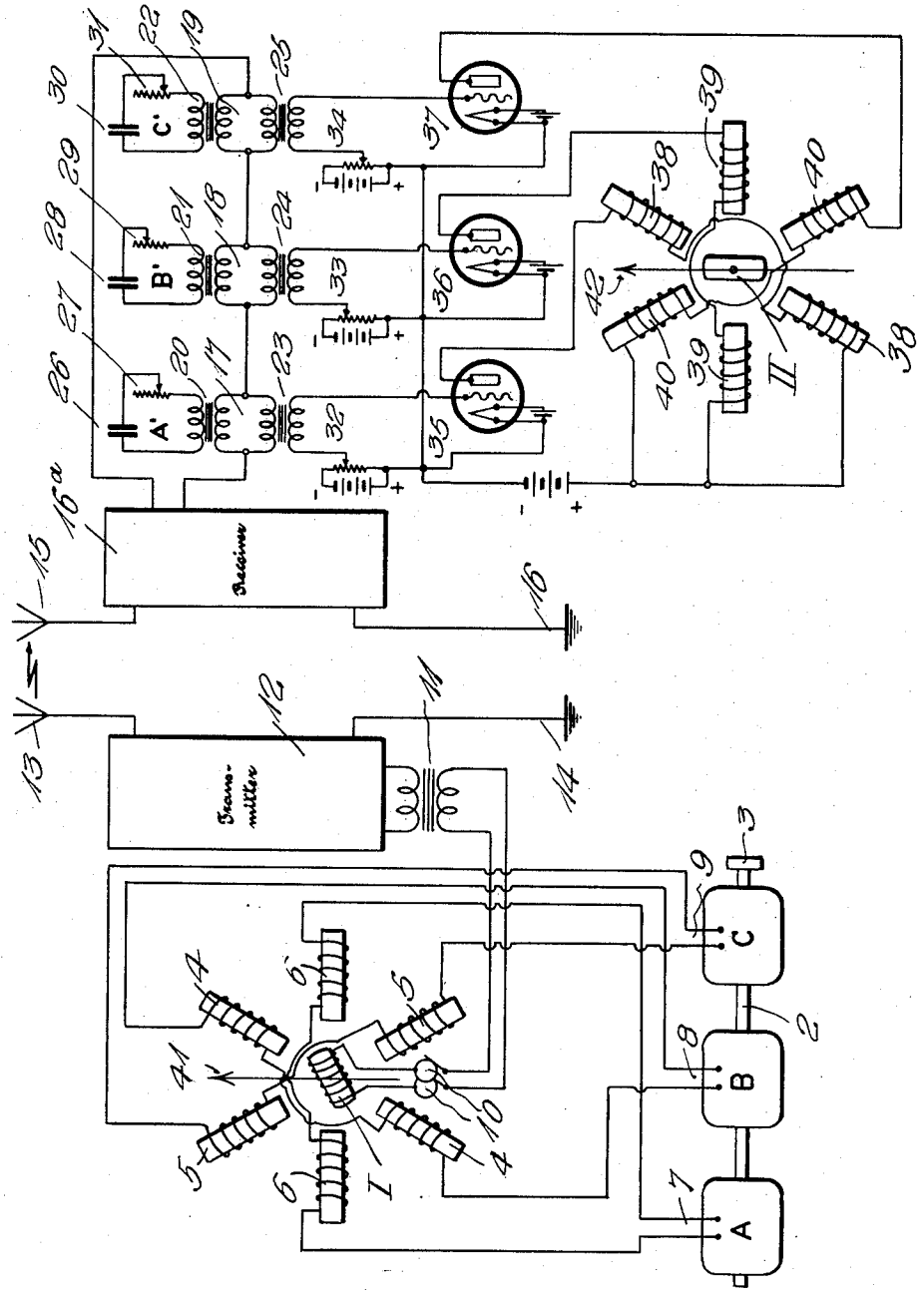
Jan. 2, 1934. C. B. MIRICK 1,941,615

MECHANISM FOR RADIO OPERATED REPEAT MOTION

Filed Aug. 14, 1930



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Patented Jan. 2, 1934 1,941,615

UNITED STATES PATENT OFFICE

1,941,615

MECHANISM FOR RADIO OPERATED REPEAT MOTION

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Application August 14, 1930. Serial No. 475,291

8 Claims. (Cl. 250—2)

My invention relates broadly to remote control systems and more particularly to a circuit arrangement for a radio operated repeat motion.

One of the objects of my invention is to provide a simplified circuit arrangement for accurately reproducing the movement of an indicator remote from a distant control position by combining the effects of a multiplicity of signaling frequencies at a receiver according to a multiple modulated transmitter system.

Another object of my invention is to provide a circuit arrangement for transmitting control signals of variable tone frequency and combining the effects of the variable tone frequencies selectively at a receiver for reproducing the movement of a control mechanism at the distant transmitter.

A further object of my invention is to provide a remote control system for reproducing mechanical movements at a distant station under control of a master station in which only a single carrier frequency is required occupying a minimum width on the available frequency spectrum while performing a multiplicity of control functions by the effect of a selected modulated frequency or combination of modulating frequencies.

Other and further objects of my invention reside in a simplified system for accurately reproducing mechanical movements at a receiving station under control of a master mechanism at a distant transmitting station as will be more fully pointed out in the specification hereinafter following by reference to the accompanying drawing which diagrammatically shows the circuit arrangement of my invention.

Heretofore in the art it has been proposed to repeat the reading of the gyro compass on ship board on compass cards at different locations on the ship. Such systems employ a multiplicity of line wire circuits and are relatively complicated. In utilizing a radio link in a system for producing a repeat motion, individual circuits are not available and by reason of the congested condition of the ether and the wide demand for signaling frequencies it is not practical to employ a wide band of carrier frequencies for control purposes. I have developed a mechanism for radio operation of simplified construction by which a mechanical movement performed at a master station may be accurately reproduced at a distant receiving station wherein the system operates on a single carrier frequency. I provide means for multiply modulating the transmitter at different audio frequencies to effect a selected operation. At the master station I provide a multiplicity of permanently established electromagnetic fields with predetermined frequency characteristics. The mechanism at the master station carries an electromagnetic winding which is angularly movable in the permanently established electromagnetic field. When the mechanism of the master station is shifted to a selected position the winding is electromagnetically coupled with a selected electromagnetic field or combination of electromagnetic fields of different frequencies. The transmitter is therefore multiply modulated at a selected frequency or combination of frequencies in accordance with the position of the mechanism at the transmitter. At the distant receiver I provide means for receiving the transmitted signaling energy and a multiplicity of circuits responsive to the different modulated notes of the transmitter. That is, separate frequency selection circuits are arranged at the receiver in positions directly related to the angular positions of the means at a distant transmitter which create magnetic fields of different frequencies. A moving element disposed in the several magnetic fields at the receiver selectively responds to the reproduced magnetic field of a particular frequency or combination of magnetic fields depending upon the position of the control element at the distant transmitter. Only a single carrier frequency is employed but any number of audio notes may be employed for effecting the required control.

My invention may be applied to various types of repeat motions, one example of which is a compass system. A compass card at the transmitter may be attached to the angularly movable element for controlling the distant receiver where a similar compass card may be angularly shifted to a position corresponding to the position of the compass card at the distant transmitter.

Referring to the drawing in detail, reference I designates a rotatable armature winding which is adapted to be angularly moved within a multiplicity of electromagnetic fields of differing frequency characteristics. The electromagnetic fields have been designated as established by sets of radialy disposed electromagnetic windings designated at 4, 5 and 6. The sets of windings, 4, 5 and 6 are independently excited from suitable sources of different audio or tone frequency such as generators operating at different audio frequencies spaced one from another along the acoustic frequency spectrum, the generators being indicated at A, B and C having leads 7, 8 and 9 extending therefrom to the sets of field

windings. That is field windings 4 are energized from the alternator B through leads 8 at one frequency. The field windings 5 are energized from alternator C through leads 9 at a different frequency. The sets of windings 6 are energized from alternator A through lead 7 at still a different frequency. The rotatable armature winding I is selectively magnetically coupled with any one of the several angularly disposed electromagnetic fields or combinations thereof. In the position shown for example, the armature winding I is electromagnetically coupled both with the set of windings 4 and the set of windings 6. The armature winding I has the terminals thereof connected to the collector rings 10 which lead to the primary winding of modulation transformer 11. The transformer 11 has its secondary winding connected in the modulation circuit of the transmitter 12 which radiates signaling energy from antenna ground system 13—14 modulated at different tone frequencies according to the coupling of armature winding I with the several electromagnetic fields. The alternators A, B and C are interconnected by shaft 2 driven by any suitable prime mover which connects at 3 to driving shaft 2. Armature winding I is connected to the mechanical device from which a repeat motion is to be transmitted such as the indicator 41 or a rotatable compass card.

At the receiving station the antenna-ground system 15—16 connects to the receiving apparatus 16*a*, the output circuit of which includes a multiplicity of frequency discriminating circuits. I have shown these circuits as including audio frequency transformers 23, 24 and 25, the primary windings of each of which are shunted by the primary windings of transformers 20, 21 and 22 forming closed circuits 17, 18 and 19. Tuned trap circuits A', B' and C' are connected to the secondary windings of transformers 20, 21 and 22 respectively and tuned to correspond to the modulating frequencies A, B and C at the transmitter. The tuned trap circuit A' includes tuning condenser 26 and variable resistance 27, each of which may be adjusted to the characteristics of the modulating frequency A. The tuned trap circuit B' includes tuning condenser 28 and variable resistance 29 which are adjusted to tune the circuit to the modulating frequency of alternator B. Tuned trap circuit C' is adjusted by means of tuning condenser 30 and variable resistance 31 to the frequency of the modulating source C at the transmitter. The audio frequency transformers 23, 24 and 25 connect to the input circuits of electron tube rectifiers 35, 36 and 37, respectively, the bias potential for each of which are adjusted by variable taps 32, 33 and 34. The output circuit of each rectifier includes sets of radially positioned field windings which I have designated at 38, 39 and 40. A rotatable armature II is disposed within the field established by the several sets of field windings and the armature connected with an indicator 42 or a compass card similar to the indicator 41 or compass card at the transmitter. Field windings 38 are connected in the output circuit of rectifier 35. Field windings 39 are connected in the output circuit of rectifier 36. The set of field windings 40 are connected in the output circuit of rectifier 37. The several sets of windings are energized to establish an electromagnetic field if the associated rectifier circuit is excited and the associated rectifier circuit only responds to a predetermined frequency emitted by the transmitter. It will be understood that armature winding I picks up a modulation which depends upon the position of winding I. When directly in line with one of the magnets of a master system this will be a single frequency, and when midway between two masters, it will be a double modulation, half of one frequency and half of another. This modulation when transmitted to the receiving end will be separated into its component frequencies between tuned traps A', B', C' in a manner proportional to the rotation of I. After rectification, there results direct current in the magnet coils surrounding armature II which follows this same relation. Therefore, the driven rotor armature II when once oriented, will follow faithfuly the motions of the driving armature I. It will be noted that a single radio channel is sufficient for carrying this repeater motion and that the action is continuous and not step by step which makes the repetition extremely accurate. In order to make the repetition perfect, it is necessary to adjust the sharpness of tuning of the three tuned output systems for proper relation with the field distribution of the elements in the driving transformer. This is done by varying the resistance 27, 29 and 31 in the tuned trap circuits A', B', C'.

By the combined action of the electromagnetic field from the several sets of electromagnets, the indicator 42 or associated compass card is shifted to a position corresponding to the position of the indicator or compass card 41 at the transmitter. The frequency discriminating circuits A', B' and C' screen the rectifiers in such manner that one or more of the rectifiers are energized according to the particular frequency or combination of frequencies at which the transmitter is modulated. As heretofore explained this depends upon the angular position of winding I with respect to the sets of electromagnetic windings at the transmitter.

While I have referred to the circuits as including an antenna-ground circuit, it will be understood that any form of radio frequency emission or reception circuit may be employed such as a doublet, a loop or other form of collector or emitter.

While I have described my invention in a certain preferred embodiment, I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A radio operated repeat motion system comprising a transmitter adapted to emit a predetermined carrier frequency for reception by a distant receiver, circuits at said transmitter for variably modulating said carrier frequency according to the position of a master mechanism at different audio frequencies and intermediate frequencies constituted by combinations of the aforesaid frequencies, and circuits at said receiver adapted to respond to the frequency modulations of said carrier frequency and a repeat motion mechanism controlled by said circuits for simulating the position of said master mechanism at the transmitter.

2. In a radio operated repeat motion system, a transmitter adapted to emit a predetermined carrier frequency, a receiver adapted to receive the carrier frequency thus transmitted, modulation means at said transmitter including a multiplicity of independent sources of audio fre-

quency energy each having different frequency characteristics, a multiplicity of electromagnetic fields adapted to be independently excited from said source of audio frequency energy, an electromagnetic winding, a master mechanism for shifting said electromagnetic winding within said electromagnetic fields, a modulation circuit interconnecting said transmitter with said winding whereby the carrier frequency emitted by said transmitter is variably modulated according to the coupling between said winding with either an individual electromagnetic field or combination of electromagnetic fields within which said winding is shifted, circuits at said receiver responsive to the modulated frequencies emitted by said transmitter, a repeat motion mechanism and means operated by said circuits for controlling said repeat motion mechanism for simulating the position of the master mechanism at the transmitter.

3. In a radio operated repeat motion system, a transmitter adapted to emit a predetermined carrier frequency, a receiver adjusted to respond to the carrier frequency thus emitted, a modulation circuit connected with said transmitter, a multiplicity of sources of different audio frequency at said transmitter, means connected with said sources for establishing electromagnetic fields of corresponding frequency characteristics, a winding disposed in the said electromagnetic fields and connected with said modulation circuit, a master mechanism for controlling the movement of said winding within said electromagnetic fields for establishing a coupling relationship with one or a pair of said electromagnetic fields, a multiplicity of audio frequency selection circuits connected with said receiving circuit, a repeat motion mechanism and means operated by said frequency selection circuits for actuating said repeat motion mechanism and simulating the position of said master mechanism at the transmitter.

4. In a radio operated repeat motion system, a transmitter adapted to emit a predetermined carrier frequency, a receiver adjusted to respond to the carrier frequency thus emitted, a modulation circuit connected with said transmitter, a multiplicity of sources of different audio frequency at said transmitter, means connected with said sources for establishing adjacent electromagnetic fields of corresponding frequency characteristics, a winding disposed in the said electromagnetic fields and connected with said modulation circuit, a master mechanism for controlling the movement of said winding through the adjacent electromagnetic fields for modulating said transmitter at any one of said audio frequencies when said winding is aligned with an electromagnetic field of corresponding frequency or modulating said transmitter at a different frequency when said winding is moved to a position intermediate the aforesaid electromagnetic fields for utilizing the combined effects thereof, a multiplicity of frequency selection circuits connected with said receiving circuit, a repeat motion mechanism, and a plurality of electromagnetic fields disposed radially about said repeat motion mechanism and independently excited from said frequency selection circuits for effecting angular movement of said repeat motion mechanism and simulating the movement of said master mechanism at the transmitter.

5. In a radio operated repeat motion system, a transmitter adapted to emit a predetermined carrier frequency, a receiver adjusted to respond to the carrier frequency thus emitted, a modulation circuit connected with said transmitter, a multiplicity of sources of different audio frequency at said transmitter, means connected with said sources for establishing radially extending electromagnetic fields of corresponding frequency characteristics, a winding centrally disposed for rotative movement in the said electromagnetic fields and connected with said modulation circuit, a master mechanism for controlling the movement of said winding within said electromagnetic fields for establishing a coupling relationship with one or a pair of said electromagnetic fields, a multiplicity of frequency selection circuits connected with said receiving circuit, a repeat motion mechanism, a multiplicity of electromagnetic fields radially disposed with respect to the axis of radiation of said repeat motion mechanism, and means for individually exciting each of said radially disposed electromagnetic fields from each of said frequency selection circuits or combination of adjacent electromagnetic fields for simulating the movement of the master mechanism at the transmitter.

6. In a radio operated repeat motion system, a transmitter adapted to emit a predetermined carrier frequency, a receiver adapted to respond to the carrier frequency thus emitted, a modulation circuit at said transmitter, a master mechanism at said transmitter, means controlled by said master mechanism and connected with said modulation circuit for variably modulating the carrier frequency emitted by said transmitter according to a multiplicity of differing audio frequencies and at frequencies formed by a combination of the aforesaid audio frequencies, frequency selection circuits at said receiver each adapted to respond to one of the modulating frequencies over said transmitter, a rotatably mounted repeat motion mechanism, a multiplicity of radially positioned electromagnetic windings disposed on opposite sides of said repeat mechanism, and connections between the individual frequency selection circuits and selected electromagnetic windings for variably controlling the movement of said repeat mechanism according to the position of the master mechanism at said transmitter as determined by the operation of either of said audio frequencies or combination thereof.

7. In a radio operated repeat mechanism, a transmitter adapted to emit a predetermined carrier frequency, a receiver adapted to respond to the carrier frequency thus emitted, a multiplicity of independent tone frequency circuits connected to the output of said receiver, a multiplicity of electromagnetic field windings individually controlled by the operation of said tone frequency circuits, a repeat motion mechanism controlled by said electromagnetic fields, and means at said transmitter for variably modulating the carrier frequency according to the movement of a master mechanism for correspondingly controlling the establishment of either one or combination of electromagnetic fields for correspondingly controlling the movement of said repeat mechanism.

8. In a repeat motion system, a controlling station, a controlled station comprising at the controlling station a plurality of sources of different frequency characteristics, a rotatably mounted coil, a plurality of sets of field windings arranged radially about the axis of rotation of said rotatably mounted coil, one set of said field windings being connected with each of said sources, means interconnecting the rotatable coil with said

controlling station, said controlled station including sets of radially disposed field windings, means for selecting the transmitted frequencies and applying the energy thereof individually to selected sets of said last mentioned field windings, a rotatable member concentrically disposed with respect to said last mentioned sets of field windings, and individual means connected with each of said last mentioned field windings for rectifying the received energy of the frequency corresponding to the said winding for producing a direct current change corresponding to the frequency variation at the controlling station for angularly moving said member to a position corresponding to the position of said rotatably mounted coil at the controlling station.

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