Feb. 18, 1947. P. F. BECHBERGER ET AL 2,415,985

PERMANENT MAGNET TELEMETRIC SYSTEM

Filed March 12, 1942

Fig. 1

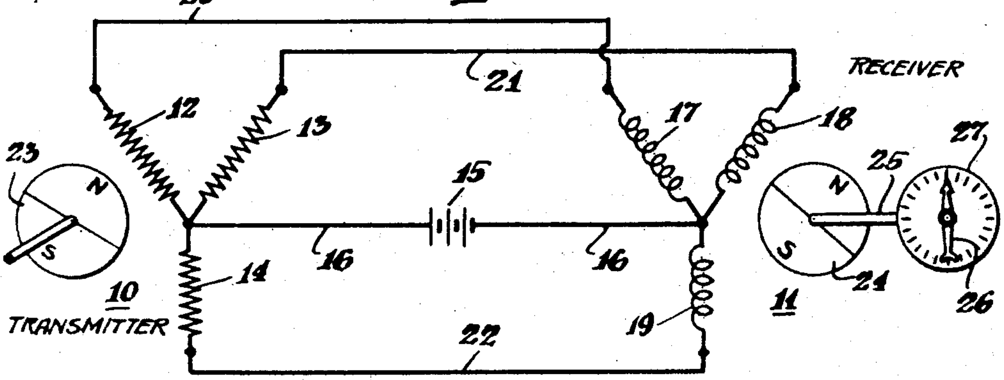


Fig. 2

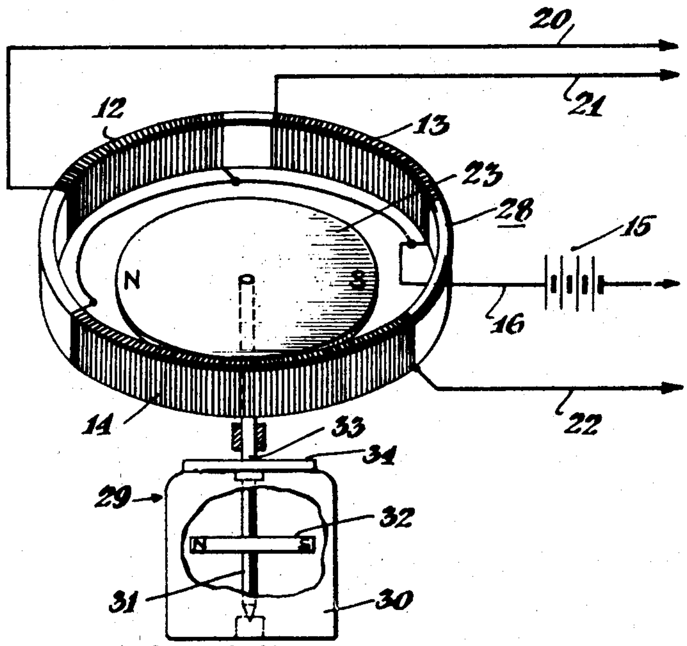
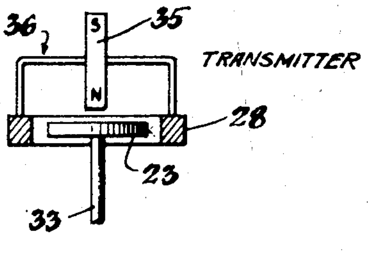


Fig. 3



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PERMANENT MAGNET TELEMETRIC SYSTEM

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4 Claims. (Cl. 172—239)

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The present invention relates to self-synchronous systems and more particularly to systems with the use of which motion of any kind at one point may be transmitted to and reproduced at another and remote point.

Systems of this general nature are known in the art as illustrated, for example, by the patent to W. A. Reichel, No. 2,269,602, issued January 13, 1942, and assigned to the assignee of the present application. These systems, however, have a limited application since they depend entirely for operation upon the presence of an alternating current source upon the vehicle or device upon which the system is used.

Other systems have been devised, such as that illustrated in the United States patent to F. Lauck, No. 2,178,306, issued October 31, 1939, to operate from a direct current source where no alternating current is available. With the use of the latter systems, however, serious drawbacks have resulted because to be operative the direct current systems necessitated the use of brushes, commutators, or sliding contacts. The use of these elements obviously hindered correct remote transmission of motion from one point to another point because considerable torque is needed to overcome the friction created with the use of brushes, commutators or sliding contacts. These systems are especially undesirable where the movement of a sensitive instrument, such as a magnetic or gyroscopic compass, is to be reproduced at a remote point because only a limited amount of torque is available at the instrument.

An object of the present invention, therefore, is to provide a novel direct current self-synchronous system which overcomes the foregoing disadvantages.

Another object of the present invention is to provide a novel brushless direct current self-synchronous system.

A further object of the invention is to provide novel means for reproducing motion at a remote point.

Another object of the invention is to provide a novel transmitter having no brushes, commutators or sliding contacts for use in a direct current self-synchronous system.

Still another object of the invention is to provide a novel direct current remote control system with the use of which an object or device at one point may be controlled by an object or device at another and a remote point.

A further object is to provide a novel direct current remote control system having a novel

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transmitter which dispenses with the use of brushes, commutators or sliding contacts.

Another object of the invention is to provide a novel, brushless, direct current transmitter having several interconnected conductor elements which are formed of a substance such as bismuth, for example, so that the electrical resistance of the conductors varies in the presence of a magnetic field.

The foregoing and other objects and advantages of the invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawing wherein one embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawing is for purpose of illustration and description only and is not intended as a definition of the limits of the invention.

In the drawing wherein like reference characters refer to like parts, throughout the several views;

Figure 1 is a diagrammatic illustration of one form of the novel apparatus embodying the present invention and shows a transmitter and a receiver with their magnetic and electrical circuits and connections;

Figure 2 is a detail view of the novel transmitter of Figure 1 showing the arrangement of the novel stator resistors with the rotor magnet; and

Figure 3 is a fragmentary schematic view illustrating an arrangement of biasing means for the transmitter of Figure 2.

The present invention contemplates the provision of a novel direct current repeater system having a brushless transmitter connected electrically with a remote receiver whereby motion of any kind detected at the transmitter is reproduced at the receiver. The problem heretofore encountered with the use of known direct current repeater systems was that the brushes, commutators or sliding contacts thereof demanded constant attention and frequent repair or replacement. It is known that the electrical resistance of bismuth to the flow of current is varied in the presence of a strong magnetic field. This latter property of bismuth is utilized to provide a novel direct current repeating system having a brushless and contactless transmitter device thereby overcoming the foregoing disadvantages associated with the use of known systems.

Referring now to the drawing for a more detailed description of the present invention and particularly to Figure 1 thereof, a novel repeater system is shown comprising a transmitter 10 which is electrically connected to a remote receiver 11.

Transmitter 10 comprises a stator having three resistors 12, 13 and 14 which are connected together at a common mid-point with a suitable source of direct current 15 by way of a conductor 16.

Stator resistors 12, 13 and 14 are constructed so as to be substantially alike and under normal conditions have equal currents flowing therethrough from source 15. Furthermore, in accordance with the present invention, these resistors are formed of a substance such as bismuth, for example, whose electrical resistance varies in the presence of a magnetic field.

Receiver 11 comprises a stator having three windings 17, 18 and 19 which, through a common mid-point, likewise, connect by way of conductor 16 with the other side of source 15. The free ends of windings 17, 18 and 19 connect by way of leads 20, 21 and 22 with the free ends of resistors 12, 13 and 14.

The transmitter stator resistors 12, 13 and 14 have magnetically associated therewith a rotor 23 comprising a rotatable magnetic disc, one half of which defines the North pole designated at N and the other half of which defines the South pole designated at S. Angular movement of transmitter rotor 23 relative to its stator causes an equal and corresponding angular movement, in a manner to presently appear, on the part of a receiver rotor 24, which, like rotor 23, comprises a rotatable magnetic disc, one half of which defines the North pole designated at N and the other half of which defines the South pole designated at S.

Receiver rotor 24 is mechanically coupled by means of a shaft 25 with a suitable indicator 26 superimposed for movement over a calibrated dial 27. Only one repeater 11 has been shown in the present instance but it is to be specifically understood that any number of such receivers may be used at different points, all of which would be electrically connected to connecting leads 20, 21 and 22 in the same manner that receiver 11 is connected thereto.

Transmitter 10, shown diagrammatically in Figure 1, may be constructed somewhat in the manner as illustrated in Figure 2, which comprises winding resistors 12, 13 and 14 about an annular supporting stator member 28, with a like end of each resistor connected to source 15 by way of the common conductor 16 and with the free ends thereof to the receiver 11 of Figure 1 by way of leads 20, 21 and 22.

For purposes of illustration, magnetic transmitter rotor 23 is shown in Figure 2 as influenced and controlled by a magnetic compass 29 which may be of any known type and comprises a compass bowl 30 having mounted therein, in suitable bearings, a spindle 31 carrying a compass needle or element 32. Rotor 23 is arranged concentrically with the annular supporting member 28 and its resistors and, furthermore, is rotatably mounted for movement with compass needle 32 upon a spindle 33 which may be connected to or formed integrally with spindle 31.

Magnetic compass 29, furthermore, may be provided with a conventional deviation compensator 34 of any known type at the top thereof.

Bismuth resistors, though sensitive to a change in the intensity of a magnetic field, are not selective as to the direction of the effective magnetic field. Stated in another manner, if the

magnetic rotor of Figure 2 were in a position wherein its N pole were directly opposite resistor 14 and its S pole directly opposite resistor 13, the resistance of both stator resistors 13 and 14 would vary an equal amount. To compensate for this fact and make the resistors sensitive to direction of the field as well as to the intensity thereof, a stationary magnet 35 is provided, as shown in Figure 3, suitably mounted on the annular stator member 28 by means such as a bracket 36, with its N pole directly above the central axis of rotor 23. Magnet 35 acts to provide a biased field emanating from rotor 23 because the N pole of magnet 35 acts additively with the N pole of rotor 23 and differentially with the rotor S pole. Thus, stator resistors 12, 13 and 14 are made sensitive to both the direction and intensity of the rotor field.

When the craft or moving object, upon which the present novel system is mounted, deviates from a northerly or prescribed course, the compass bowl 30 moves angularly therewith but the compass needle 32 remains in its original position so that relative movement results between the compass bowl and the needle, the amount of such relative movement being the amount of the angular departure of the craft or moving object from its northerly or prescribed course.

The stator of transmitter 10, like compass bowl 30, is fixed to the craft or moving object so that it, too, moves angularly with the craft or object producing thereby relative movement between the annular supporting member 28 with its stator resistors 12, 13 and 14 and the magnetic rotor 23 because the latter is coupled with the compass needle spindle 31 by way of spindle 33.

The amount of relative movement between stator resistors 12, 13 and 14 and the magnetic rotor 23 determines which of the resistors is to be influenced by the magnetic field being provided by magnetic rotor 23. Since resistors 12, 13 and 14 are all the same, the current flow through each one of them from source 15 would be the same and, obviously, should the value of the resistances not be the same the currents flowing through each of the resistances would no longer be the same.

If the amount of the angular craft movement is such as to bring resistor 12 in front of the N pole of poled rotor 23, resistor 12, being formed of bismuth, responds to the strong magnetic field of the rotor so that its electrical resistance is varied whereby the amount of current flowing through resistor 12 becomes different from the current flowing in resistors 13 and 14. The variation in the relationship of the flowing currents is communicated to the receiver windings 17, 18 and 19, and, obviously, the current flowing in winding 17 will be different in amount from the currents flowing in windings 18 and 19. The change in the currents flowing in receiver windings 17, 18 and 19 causes a change in the intensity of the magnetic fields created about each of the windings so that the effective resultant of the composite magnetic fields is varied and exerts a torque upon receiver rotor 24 until the latter moves angularly into agreement with the position of transmitter rotor 23. Movement of rotor 24 urges indicator 26 over scale 27 to indicate the amount of angular craft movement.

During a greater angular change of craft heading from a prescribed course, bismuth resistors 13 or 14 may be brought directly in front of the N pole of transmitter rotor 23 and similarly the value of their resistances would change in the presence of the strong field which change would be communicated to the receiver windings 17, 18 and 19 producing a rotating magnetic field at the receiver which coacts with the poled receiver rotor 24 to urge the latter a further angular amount corresponding to the amount of angular change of craft heading.

It will now be apparent to those skilled in the art that a novel and highly desirable direct current self-synchronous system has been provided having a novel brushless and contactless transmitter whose resistors are formed of a substance such as bismuth, the electrical resistances of which vary in the presence of a strong magnetic field. Furthermore, the system is such that all direct connections with the actuating element or instrument are dispensed with thereby overcoming the former disadvantages where the contacts or brushes engaging the transmitter resistors were connected directly to and moved by the sensitive instrument.

As stated before, the transmitter rotor 23 has been shown as connected by means of spindle 33 to compass needle spindle 31 for actuation thereby. It is to be understood, however, that the compass needle itself may act as the transmitter rotor thereby replacting the use of the transmitter rotor 23 of Figure 2, in the manner shown and described in the copending application, Serial No. 410,343, filed September 10, 1941, and assigned to the assignee of the present invention.

Although only one embodiment of the invention has been illustrated and described in detail, various changes and modifications in the form and relative arrangement of the parts, which will now appear to those skilled in the art, may be made without departing from the scope of the invention. Reference is, therefore, to be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A transmitter device comprising a stator having a closed substantially annular core member, means spaced about said core member for conducting current therethrough formed of bismuth, a rotatable magnetic rotor mounted for movement relative to said stator whose magnetic field influences the electrical resistance of said conducting means, and means providing a second magnetic field for coaction with the magnetic field of said rotor.

2. In apparatus of the class described a substantially annular stator member, current conducting means on said member formed of a material whose electrical resistance varies in the presence of a relatively movable magnetic field, a magnetic rotor mounted for movement relative to said conducting means, and means providing a second magnetic field for coaction with the magnetic field of said rotor.

3. In combination, a transmitter comprising a closed substantially annular core having resistive coil means spaced thereon, said coil means being formed of bismuth and having a single connection and a multi-circuit connection, a magnetic rotor in influencing relationship with said coil means for varying the electrical resistance of said coil means and thus the current flow therethrough, means providing a second magnetic field for coaction with the magnetic field of said rotor, a receiver comprising a stator having windings provided with a single connection and a multi-circuit connection, the multi-circuit connection of said coil means being connected to the multi-circuit connection of said receiver windings in corresponding circuit relation, a source of direct current connected to both of said single connections, and a rotatable magnetic rotor associated with said windings for actuation by the reaction between its own magnetic field and the field produced by the windings upon rotation of the magnetic transmitter rotor.

4. In combination, a transmitter comprising a closed substantially annular core having resistive coil means spaced thereon, said coil means being formed of a material whose electrical resistance varies in the presence of a magnetic field and having a single connection and a multi-circuit connection, a magnetic rotor in influencing relationship with said coil means for varying the electrical resistance of said coil means and thus the current flow therethrough, means providing a second magnetic field for coaction with the magnetic field of said rotor, a receiver comprising a stator having windings provided with a single connection and a multi-circuit connection, the multi-circuit connection of said coil means being connected to the multi-circuit connection of said receiver windings in corresponding circuit relation, a source of direct current connected to both of said single connections, and a rotatable magnetic rotor associated with said windings for actuation by the reaction between its own magnetic field and the field produced by the windings upon rotation of the magnetic transmitter rotor.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
543,843	Biggar	Aug. 6, 1895
2,013,106	Nagel	Sept. 3, 1935
2,184,347	Jewell	Dec. 26, 1939
2,226,847	Clark	Dec. 31, 1940
2,365,430	Naul	Dec. 19, 1944

FOREIGN PATENTS

Number	Country	Date
409,318	German	Feb. 4, 1925
502,144	German	July 9, 1930

OTHER REFERENCES

Fownes Manual of Chemistry, by Henry Watts, published by Henry C. Lea, Philadelphia, 1878, pages 112–113.