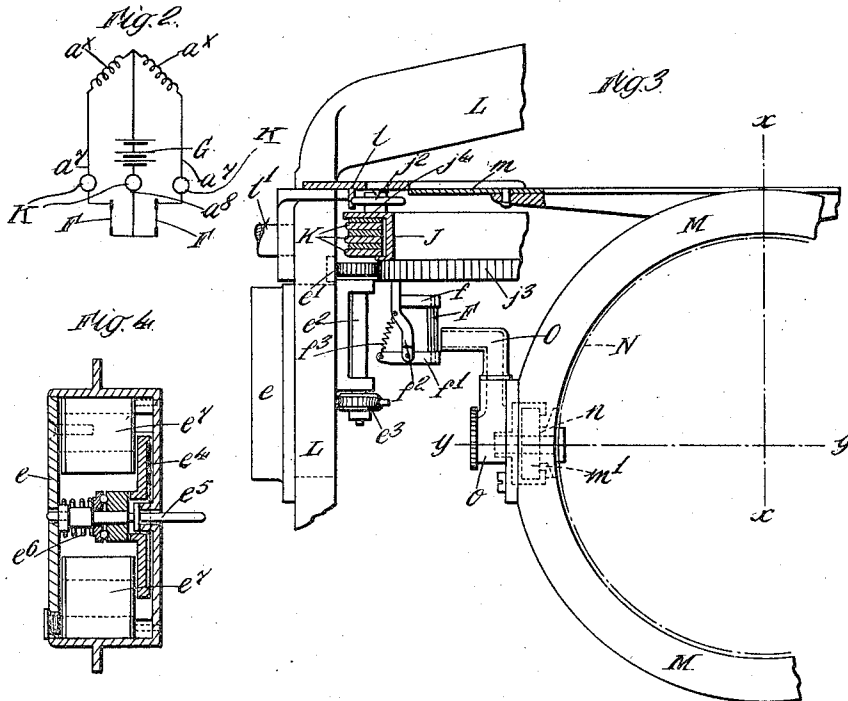
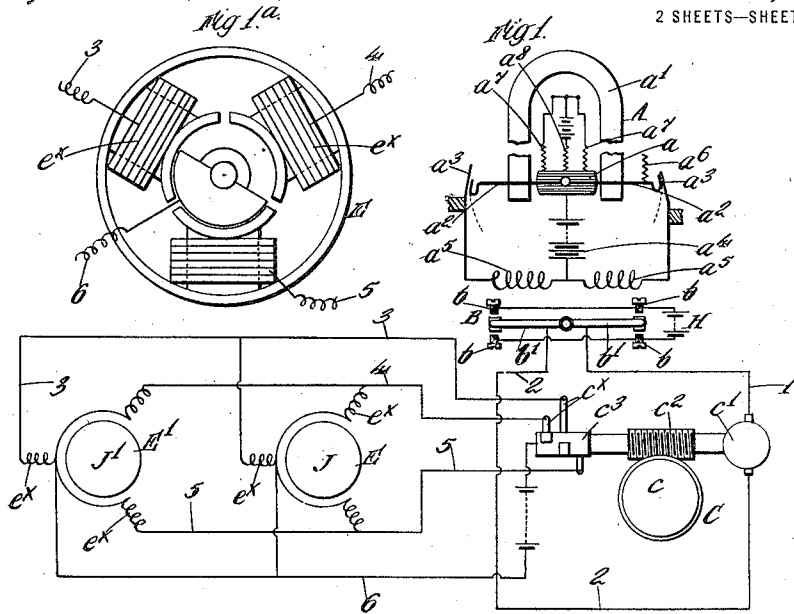


S. G. BROWN.
 REPEATER FOR GYROCOMPASSES.
 APPLICATION FILED APR. 17, 1918.

1,419,010.

Patented June 6, 1922.

2 SHEETS—SHEET 1.



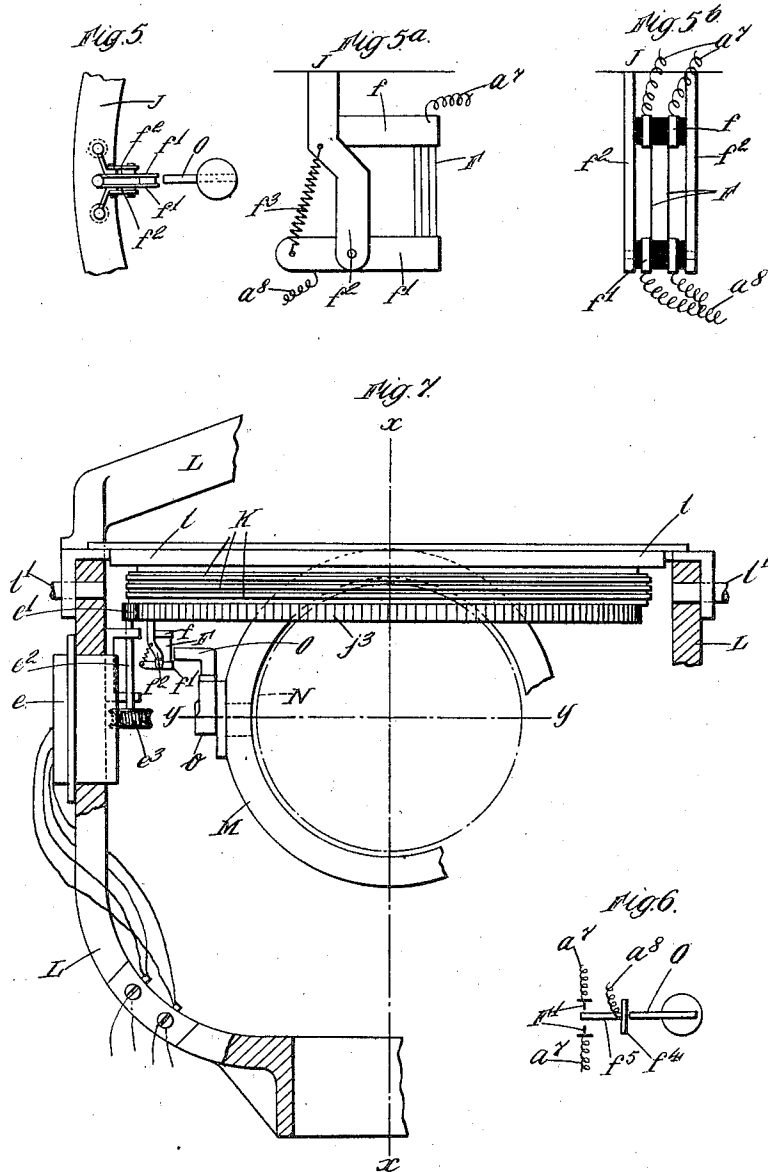
Inventor:
 Sidney George Brown,
 by *Wm. G. Thompson & Co.*
 Attys.

S. G. BROWN.
 REPEATER FOR GYROCOMPASSES.
 APPLICATION FILED APR. 17, 1918.

1,419,010.

Patented June 6, 1922.

2 SHEETS—SHEET 2.



Inventor.
 Sidney George Brown,
 by *James, Glasbarn & O'Neil*
 attys.

UNITED STATES PATENT OFFICE.

SIDNEY GEORGE BROWN, OF NORTH ACTON, ENGLAND.

REPEATER FOR GYROCOMPASSES.

1,419,010.

Specification of Letters Patent.

Patented June 6, 1922.

Application filed April 17, 1918. Serial No. 229,098.

To all whom it may concern:

Be it known that I, SIDNEY GEORGE BROWN, F. R. S., a subject of the King of Great Britain, residing at Edward Road, Willesden Lane, North Acton, in the county of Middlesex, England, have invented certain new and useful Improvements in or Relating to Repeaters for Gyrocompasses, of which the following is a specification.

This invention relates to repeaters for use with gyro-compasses and more especially to improved means by which the repeaters are made to follow the movements of the master compass.

According to this invention the transmission of the repeater system is effected by the aid of an air jet or blast derived from the air in the gyro-casing of the master compass, which air, owing to the centrifugal action set up by contact with the rotating gyro-wheel, is subjected to outwardly directed pressure, the air being allowed to escape through a suitably placed nozzle on the casing so as to control the position of the repeater or repeaters. If the gyro-casing turns around its vertical axis the air jet changes its position and any change of position acts upon the repeater system through a relay until the system takes up a position corresponding to the new position of the gyro-casing.

In one construction embodying this invention an electrical relay of hot wire type is employed. In this construction a balanced relay circuit including two hot wires or sets of hot wires in parallel is carried upon a horizontal ring or equivalent member mounted on a gimbal ring of the gyro-compass and caused to follow up the gyro-casing in its movements about the vertical axis, the air jet being directed between the two hot wires so that any angular movement would introduce inequalities of cooling and consequently of resistance which disturb the balance in the circuit and give rise to a current operating the repeater system. The relay circuit is preferably slightly out of balance when the jet is centrally between the hot wires, so that should the air nozzle, by any large movement of the gyro-casing, pass either of the wires the relay circuit would become operative and would turn the hot wire follow-up ring or carrier until the hot wires again reach the nozzle, the repeater card or cards following such movement, which is comparatively rapid and causes only a brief inter-

ruption of the repeater indications. To obtain the slight normal lack of balance the relay battery may be connected up a little to one side of the centre of the relay coil, or the tongue of the relay may be given a bias to one side by means of a spring, balance being obtained when the air jet is slightly to one side of the centre of the pair of hot wires so that the unequal cooling and consequent unequal resistance compensate for the effect of the unsymmetrical coil connection or the action of the spring. The relay operates the motor of a master repeater from which any number of repeaters can be controlled and the follow-up ring carrying the hot wires is operated by a repeater motor similar to that of the common repeater set so that the ring and the repeaters move in synchronism.

Instead of using hot wires or the like the air jet may be made to move small fans or vanes to make electrical contact and thus operate the relay and the repeater sets.

In order that the said invention may be clearly understood and readily carried into effect I will describe the same more fully with reference to the accompanying drawings in which:—

Figure 1 is a diagrammatic view of the electrical arrangements employed in transmitting the compass movements to the repeater or repeaters.

Figure 1^a shows diagrammatically one of the repeater motors.

Figure 2 is a detail diagram showing the connection between the hot wires and the moving coil of one of the relays.

Figure 3 shows partly in section a portion of the gyro-compass carrying the hot wire and air jet device.

Figure 4 is a section of a step-by-step motor shown in position in Figure 3.

Figure 5 is a detail of the device carrying the hot wires, the device being shown from below.

Figure 5^a is a side view and Figure 5^b is a face view of the said hot wire device shown on a larger scale.

Figure 6 shows a contact device which may be employed instead of the hot wires.

Fig. 7 is a view corresponding to Figure 3, but showing more of the compass.

Referring to the diagrams, Figures 1 and 2, A is the moving coil relay. B is a reversing relay. C is a master repeater. E, E' are the common repeaters, several of which may be employed, the repeater E being car-

ried on the gyro-compass. F is a pair of hot wires (or sets of wires) between which is connected a pole of the battery G connected at its other pole between the two windings a^x of the moving coil a belonging to the relay A. All the electrical parts shown, with the exception of the hot wire device and the repeater E, are carried on the switch board of the instrument, the hot wires and one of the repeaters being mounted on the gyroscope as hereinafter described.

The moving coil a oscillates between the poles of the permanent magnet a' and carries the two contact arms a^2 which meet the slanting contacts a^3 , current from the battery a^4 exciting one or other of the relay coils a^5 according to the contact a^3 which is met by the corresponding end of the arm a^2 . A small spring a^3 may be connected to the contact arm a^2 so that when the moving coil a is not excited the circuit through one of the contacts a^3 is closed, for the purpose already referred to. The reversing relay B controls the main battery H and comprises two pairs of contacts b between which the contact lever b' comprising two arms insulated from each other can oscillate under the control of the coils a^5 of the moving coil relay A. The relay B is therefore reversed according to the coil a^5 which is excited.

The master repeater C comprises a disc or ring c driven by the reversing direct current motor c' through the worm or other gearing c^2 ; the spindle of the motor carrying a distributor c^3 in the circuit of the battery H' (which may be the main battery H) from which current is sent to the step-by-step motors e of the repeaters E, E', the three windings of which motors are shown in the diagram. The reversing motor c' is connected to one arm of the lever b' by the lead 1 and to the other arm by the lead 2, the direction of movement of the motor depending upon which pair of contacts b are closed by the lever b' . The distributor c^3 has three conducting segments and the three leads 3, 4 and 5 leading to the three magnets e^x of the step-by-step repeater motors E, E' are connected to the brushes e^x of the distributor, the return lead 6 from the motors passing through the battery H' to the distributor drum. Thus every complete rotation of the distributor causes three impulses to be given to the motors. In practice there would be frequent reversals of the motor c' and corresponding reversals of the repeater motors E, which follow any changes in the master repeater C.

The general operation of the relays and electrical parts is as follows:—Any differential cooling of the hot wires F, which are carried upon the ring J of the repeater E which is mounted on the gyro-compass as hereinafter described, causes differential ex-

citation of the windings a^x of the moving coil a with the result that the contact arm a^2 makes contact with one or other of the slanting contacts a^3 according to the direction in which the cooling of the hot wires is effected. The contact arm b' of the reversing relay B closes the circuit through the main battery H in one direction or the other according to the operation of the moving coil relay and current is supplied to the direct current motor c' which turns the disc c of the master repeater C and also the distributor c^3 , causing the step-by-step motor e to turn an amount corresponding to the turning movement of the direct current motor. One of the motors e effects the turning of the ring J which carries the hot wires F in the case of the repeater E mounted upon the gyro-compass, other repeaters such as E', similarly connected up, being provided at different points on the ship, where required. When the ring J on the gyro-compass repeater is turned sufficiently to bring the hot wires F into the neutral position relatively to the air blast, the temperature of the two wires brings about balance in the circuit and the moving coil a then takes up a position of equilibrium, with the contact arm a^2 out of contact with both of the slanting contacts a^3 , the arm b' of the reversing relay B also taking up a central position and cutting out the motor c' of the master repeater C so that both the latter and the repeaters E, E' are brought to a standstill.

As the air blast employed for cooling the hot wires F may under some circumstances move past one of the wires so that the repeater system becomes inoperative, I propose to make the moving coil relay slightly out of balance so that the normal or neutral position is one in which one of the hot wires F is cooled to a slightly greater extent than the other, in order to introduce a torque in the moving coil which brings the contact arm a^2 out of contact with both of the slanting contacts a^3 . The small spring a^3 is indicated as a method of producing the out-of-balance effect but it is obvious that other methods may be employed. The result of the want of balance of the moving coil relay is that in the event of the air blast moving clear of the hot wire device the relay automatically comes into operation and closes the reversing relay contacts so that the direct current motor continues to drive the master repeater C and the associated repeaters E, E' until the repeater ring J and the hot wire device are brought again into a position of equilibrium with regard to the air blast. This may involve a complete circular movement of all the repeaters but the interruption to the indications is only a short one.

Referring now to the constructional fea-

tures of the repeater E carried by the gyro-compass, it will be seen from Figure 3 and Figures 5, 5^a and 5^b, that the hot wires F are carried between the two pairs of arms f , f' mounted on the downwardly depending arm f^2 , the lower pair of arms f' being pivoted and subjected to the action of the small spring f^3 which keeps the wires F taut.

The wires are arranged in a pair of elements of four wires each but a pair of single wires or of any desired number may be employed. The two upper arms f and two lower arms f' are separated by insulation and are insulated from the arm f^2 , which is fixed to the ring J.

The repeater or follow-up ring J carries the three slip rings K through which current is supplied to the hot wires from the battery G (Figure 2), the outer wires a' of the coil a (Figures 1 and 2) being connected to two of the slip rings K while the central wire a^8 is connected first to the battery G and then to the third slip ring. The ring J is mounted to turn around the vertical axis x of the gyroscope and is supported by the rollers j^2 , a series of which is placed around the ring, the outer edges of the rollers engaging in a small groove in the inner face of the relatively fixed ring l secured on the gimbal ring or pendulous frame L, which is suspended by means of the pivot pin l' and carries the step by step motor e forming the driving element of the repeater E. The lower edge j^3 of the ring J is provided with teeth and gears with the pinion e' on the shaft e^2 mounted on the frame L and driven through the worm gear e^3 by the motor e , so that the ring J and the hot wire device are turned in one direction or the other according to the movements of the step by step motor e , the motor, ring and electrical connections constituting the repeater E indicated diagrammatically in Figure 1.

Mounted to turn around the vertical axis x in the pendulous frame L is the orienting frame M carrying the compass card m and the gyro-casing N, the latter being free to tilt around the horizontal axis y in the frame M, the axis y being at right angles to the axis of rotation of the gyro-wheel rotating in the casing N, the outline of which casing is indicated in chain lines in Figure 3.

The gyro-wheel and casing act as a centrifugal air pump owing to the rotation at high speed of the wheel and the air pressure so produced is employed to control the repeater system. The pivot pin n at one side of the gyro-casing (and carried in ball bearings m' in the ring or orienting frame M), is made hollow and forms an air jet leading the air into the air box o of the air nozzle or director O mounted upon the frame M. The nozzle, while fed with air from the casing

N, does not take part in any tilting movements of the casing but turns only with the frame M around the vertical axis x , so that it follows the compass card m .

The operation of the repeater apparatus is as follows:—

Any movement of the orienting frame around the vertical axis x causes a deflection of the nozzle O which moves from its normal or neutral position between the pair of hot wires F, causing the relays A and B to become operative as described with reference to Figures 1 and 2 and the step by step motor e to turn in synchronism with the direct current motor e' . The motor e turns the ring J through the gearing e' , e^2 , e^3 in such a direction, depending on the direction of relative cooling of the hot wires F, as to move the ring and the hot wires into neutral position relatively to the new position of the air nozzle O. The relays A and B then cease to operate and all the repeaters C, E and E' stop. Any movement of the orienting frame and compass card around the vertical axis is thus repeated throughout the repeater system to a close degree of accuracy, the wires F being separated only by a short distance and the air nozzle giving a narrow stream of cooling air.

To ensure the step by step motor e stopping instantly when the current is cut off, the armature e^4 , made in the form of a notched disc and mounted on the shaft e^5 carrying the worm of the gear e^3 , is, as shown in Figure 4, normally pressed against the case of the motor by the small spring e^6 , the exciting current through the magnet coils e^7 acting to lift the armature before turning it. As soon as current ceases the armature springs back against the motor case and acts as a brake.

Instead of the hot wire device above described the relay transmission may be effected by the contact device shown in Figure 6, in which the air nozzle O is directed against a vane f^4 on the end of a contact arm f^5 moving between the pair of contacts F' which serve in place of the hot wires F and may be placed in the circuit of the moving coil relay A, if an electrical repeater system on the lines shown in Figure 1 is employed, the operation of the repeater system being similar to that already described excepting that the relay circuit is made and broken and reversed instead of the current being changed by the differential hot wire device.

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

1. In a repeater system for gyro-compasses, an air jet carried by the master compass and supplied with air under pressure derived from the gyro-casing and means, controlled by and adapted to follow up the

movement of the air jet, for causing the repeater system to follow the movements of the jet.

2. In a repeater system for gyro-compasses, an air jet carried by the master compass and supplied with air under pressure derived from the gyro-casing, an electrical relay controlling the operation of the repeater system and means for controlling the said relay by the air jet which means is adapted to follow up the movements of said jet, for the purpose specified.

3. In a repeater system for gyro-compasses, an air jet carried by the master compass and supplied with air under pressure derived from the gyro-casing, an electrical relay controlling the operation of the repeater system and a differential hot wire device in the relay circuit adapted to be acted upon by the air jet, for the purpose specified.

4. In a repeater system for gyro-compasses comprising a gyro-casing, an orienting frame and outer supporting frames, a follow-up ring mounted on a supporting frame of the said compass, a relay circuit, a circuit controlling device for said circuit mounted on the said follow-up ring, an air directing jet on the orienting frame of the compass and effecting the operation of the circuit controlling device and an air supply jet on the gyro-casing, adapted to supply the directing jet with air under pressure from the gyro-casing, for the purpose specified.

5. In a repeater system for gyro-compasses comprising a gyro-casing, an orienting frame and outer supporting frames, a follow-up ring, a repeater operating relay circuit having a controlling device on the said ring, a track carried by a supporting frame of the compass, an air-directing jet on the orienting frame of the compass and effecting the operation of the circuit controlling device, means for supplying the directing jet with air under pressure, a series of rollers supporting the follow-up ring and running in the said track, and a step-by-step motor on the said supporting frame, adapted to drive the follow-up ring, for the purpose specified.

6. In a repeater system for gyro-compasses, an air jet carried by the master compass and movable therewith, an electrical repeater operating relay system and a moving relay circuit controlling device normally adjacent to and adapted to follow up the movements of the said air jet and under its control, the said relay system being out of balance when the circuit controlling device is freed from the action of the air jet, for the purpose specified.

7. In a repeater system for gyro-compasses, an air jet carried by the master com-

pass and movable therewith, a moving coil relay the circuit controlling device of which is normally adapted to follow up and be under the control of the air jet, means for holding over the said moving coil relay in one position when free of the air jet control and a reversing relay controlled by the moving coil relay and adapted to effect the operation of the repeater system.

8. In a repeater system for gyro-compasses, an air jet carried by the master compass and movable therewith, a moving coil relay the circuit controlling device of which is normally adapted to follow up and be under the control of the air jet, a repeater operating reversing relay controlled by the said moving coil relay and a spring on the latter relay adapted to cause the reversing relay to be held in one direction when the moving coil relay is out of the control of the air jet, for the purpose specified.

9. A repeater system for gyro-compasses, comprising an air jet on the master compass, an electrical relay system the controlling element of which is under the control of the air jet, a master repeater having a relay operated reversible motor, a current distributor on the said motor and repeaters having step-by-step motors operated through the said distributor, one of which repeaters is on the master compass and carries the controlling element of the said electrical relay system, for the purpose specified.

10. In a repeater system for gyro-compasses, an air jet carried by the master compass, an electrical relay system operated by the air jet for controlling the repeaters, comprising a follow-up ring on an outer non-directive element of the compass and carrying three slip rings in the relay circuit, and a differential hot wire device in the said circuit and carried by the follow-up ring, which hot wire device is connected up centrally and at each side to the three slip rings, and means controlled by the system to control the follow up ring so as to keep the hot wire device in the line of the air jet, for the purpose specified.

11. A synchronous transmission system for a gyroscopic compass system, comprising the combination of a master gyroscopic compass having a moving element, means thereon for developing a current of air directed from the moving element, a follow-up mechanism, an electric transmitter, means mounted on the follow-up mechanism of the master compass and cooperating with the current of air for causing operation of the transmitter in accordance with movements of the moving element of the master compass, a plurality of repeaters each having an actuating motor and connections from the transmitter to the motors of all repeaters.

SIDNEY GEORGE BROWN.