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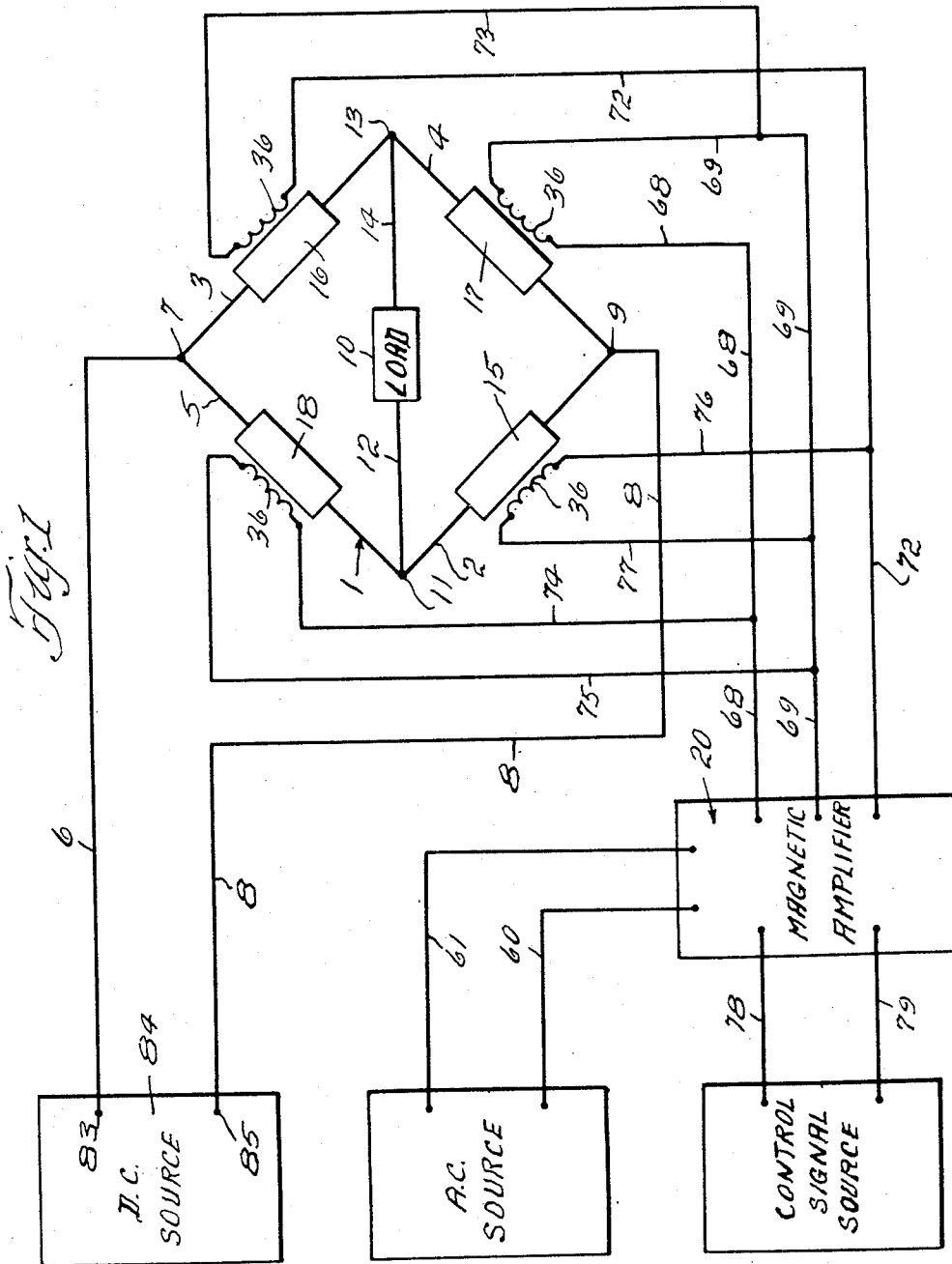
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2,878,442

MAGNETIC-CARBON FILE CONTROLLER

Filed July 26, 1956

2 Sheets-Sheet 1



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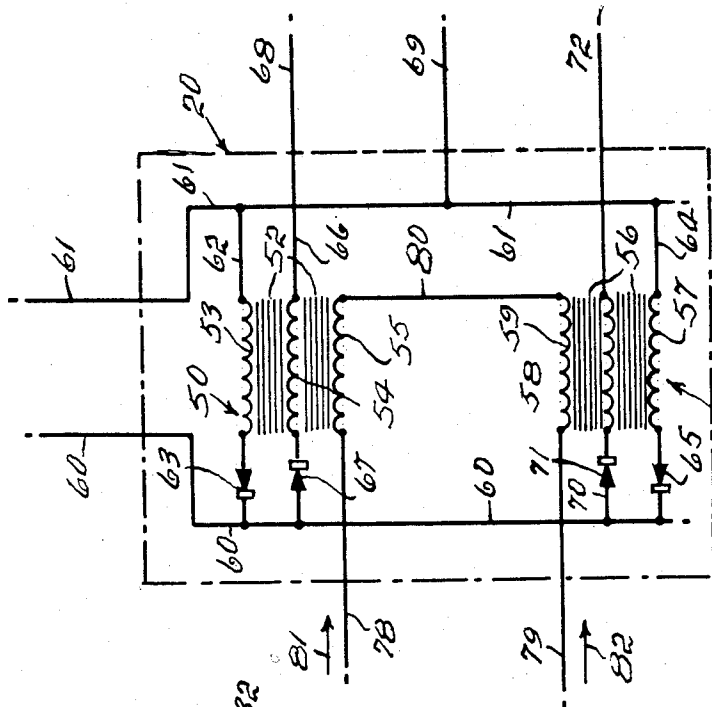
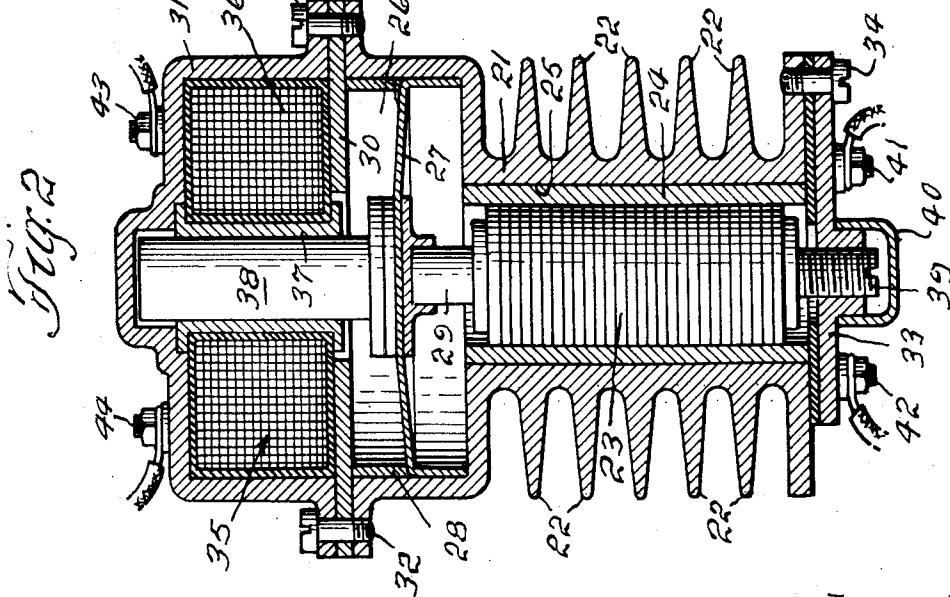
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MAGNETIC-CARBON PILE CONTROLLER

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2 Sheets-Sheet 2



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MAGNETIC-CARBON PILE CONTROLLER

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4 Claims. (Cl. 323—75)

This invention relates broadly to a control mechanism for providing a bi-polar controlled source of direct current (D. C.). More specifically the invention relates to means for electronically controlling the direction of flow and the magnitude of current in various types of load. A typical application of the invention is the controlling of the direction and magnitude of current in a D. C. field of a shunt motor.

The invention comprises generally four electrically controllable compressible carbon pile variable resistance devices arranged in a bridge circuit. The characteristic of carbon pile devices of this character are such that D. C. current of any magnitude can be directed through a load in either direction by causing the current flowing through one pair of the carbon piles to be of greater magnitude than the current flowing through the other pair of carbon piles. The direction of flow through the load is dependent upon which pair of carbon piles has the larger current flowing therethrough, and the magnitude of the current applied to the load is dependent upon the difference in magnitude of the current flowing through the opposed pairs of carbon piles. The carbon piles are controlled by a magnetic amplifier in accordance with a control signal imparted to the magnetic amplifier. The specific construction of the carbon pile devices is immaterial as anyone of a number of electrically controlled compressible carbon pile devices commercially available may be used; like the specific construction of the magnetic amplifier used is immaterial as anyone of a number of well known magnetic amplifier circuits may be used.

The principal object of the invention is to provide an improved mechanism for electronically controlling the direction and magnitude of direct current (D. C.) flowing through various types of load.

Another object of the invention is to provide a mechanism of the aforesaid character which is of simple construction, relatively small in size, has a longlife, and is highly efficient in operation.

Another object of the invention is to provide a mechanism of the aforesaid character in which all relays and electron tubes are eliminated.

Other and more limited objects of the invention will be apparent from the following specification and the accompanying drawing forming a part thereof, in which:

Fig. 1 is a diagrammatic layout of the preferred embodiment of my invention;

Fig. 2 is a central vertical section through one form of an electrically controllable compressible carbon pile variable resistance device which may be used in the mechanism of my invention; and

Fig. 3 is a diagrammatic view of a typical magnetic amplifier circuit which may be used in connection with my invention.

Referring now to the drawing by reference characters the numeral 1 indicates generally a conventional bridge circuit having the four legs 2, 3, 4 and 5 respectively. The positive terminal of a source of direct current is connected by a conductor 6 to the bridge circuit 1 at the

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junction 7 of the legs 3 and 5; and the negative terminal thereof is connected by a conductor 8 to the bridge circuit 1 at the junction 9 of the legs 2 and 4. A load 10, such as the field of a shunt motor, has one side thereof connected to the bridge circuit 1 at the junction 11 of the legs 2 and 5, as indicated by the conductor 12, and the other side thereof connected to the bridge circuit 1 at the junction 13 of the legs 3 and 4 indicated by the conductor 14.

The direction of the flow of current from the D. C. source through the load 10, and the magnitude thereof, are controlled by two pair of electrically controllable compressible carbon pile variable resistance devices 15 and 16 and 17 and 18 respectively which are interposed in the bridge circuit 1 for operation in conjunction with each other. The first pair 15 and 16 are interposed in the legs 2 and 3 respectively of the bridge circuit 1; and the other pair 17 and 18 are interposed in the legs 4 and 5 respectively of the bridge circuit 1. The four carbon pile devices are identical in construction and operation, and the conjunctive operation thereof is automatically controlled by magnetic amplifier means, generally indicated by the numeral 20, in accordance with a control signal imparted to the magnetic amplifier means 20.

As previously stated there are many differently constructed electrically controllable compressible carbon pile devices of the aforesaid character available any one of which may be used equally well in the control mechanism of my invention. In Fig. 2 of this drawing I have shown more or less generally a typical form thereof. As shown therein each of the carbon pile devices 15, 16, 17 and 18 comprises a metal casing 21 provided with heat dissipating fins 22. A pile 23 of carbon discs is mounted in an open ended tube 24 which is disposed in a reduced central bore 25 in the casing 21 and which bore communicates at one end thereof with an enlarged annular chamber 26 at one end of the casing. A spring diaphragm 27, which is mounted in the chamber 26 and held in place by a ring 28, carries a button 29 which engages one end of the carbon disc pile 23. The outer end of the chamber 26 is closed by a centrally apertured plate 30 and cap 31 which are removably secured to the casing 21 by cap screws 32; and the outer end of the bore 25 is closed by a terminal plate 33 which is removably secured to the casing 21 by cap screws 34. A solenoid generally indicated by the numeral 35 is suitably secured within the cap 31. The solenoid 35 is of conventional construction and comprises the winding 36 which is wound upon the tube 37. Energization of the coil 36 will draw the core or armature 38 inwardly which will depress the diaphragm 27 and button 29 and compress the pile 23 of carbon discs, thereby decreasing the resistance to the flow of current through the carbon pile in proportion to the pressure applied to the carbon pile by the armature 38, which pressure is dependent upon the magnitude of the current flowing through the coil 36. The normal compression of the carbon pile 23 when the coil 36 is deenergized may be adjusted by an adjusting screw 39 carried by the plate 33 and enclosed within a cap 40. The carbon pile 23 is connected into the bridge circuit 1 by means of terminals 41 and 42; and the solenoid winding 36 is connected into its circuit by terminals 43 and 44.

The magnetic amplifier means 20, by which the conjunctive operation of the pair 15 and 16 of carbon pile devices and the opposed pair 17 and 18 thereof is controlled in response to and in accordance with a control signal imparted to the magnetic amplifier means, comprises two similar saturable core reactors 50 and 51. The reactor 50 comprises the core 52, and the bias winding 53, the anode winding 54 and the control winding 55 which

are wound thereon; and the reactor 51 comprises the core 56 and the bias winding 57, the anode winding 58 and the control winding 59 which are wound thereon. The magnetic amplifier means 20 is connected to an A. C. source by the conductors 60 and 61. The bias winding 53 of the reactor 50 and a rectifier 63 are connected in series across the conductors 60 and 61 by a conductor 62; and the bias winding 57 of the reactor 51 and a rectifier 65 are connected in series across the conductors 60 and 61 by a conductor 64.

One end of the anode winding 54 of the reactor 50 is connected to the conductor 60 in series with a rectifier 67 by a conductor 66, and the other end of the winding 54 is connected to one end of the solenoid winding 36 of the carbon pile device 17 by the conductor 68. The other end of the winding 36 of the device 17 is connected to the conductor 61 by the conductor 69. One end of the anode winding 58 of the reactor 51 is connected to the conductor 60 in series with a rectifier 71 by the conductor 70, and the other end of the winding 58 is connected to one end of the solenoid winding 36 of the carbon pile device 16 by the conductor 72. The other end of the winding 36 of the device 16 is connected to the conductor 61 by the conductors 73 and 69.

The solenoid winding 36 of the carbon pile device 18 is connected to the reactor 50 in parallel with the winding 36 of the device 17 by the conductor 74, which is connected to the conductor 68, and the conductor 75 which is connected to the conductor 69; and the solenoid winding 36 of the carbon pile device 15 is connected to the reactor 51 in parallel with the winding 36 of the reactor 16 by the conductor 76, which is connected to the conductor 72, and the conductor 77 which is connected to the conductor 69.

One end of the control winding 55 of the reactor 50 is connected to the control signal source by the conductor 78, and one end of the control winding 59 of the reactor 51 is connected to the control signal source by the conductor 79. The other ends of the control windings 55 and 59 are connected together by the conductor 80.

The operation of the mechanism will now be described. In the absence of any signal in the control windings 55 and 59 of the reactors 50 and 51 the electrical output of the reactor 50 to the solenoid windings 36 of the resistance devices 17 and 18 will balance the electrical output of the reactor 51 to the solenoid windings 36 of the resistance devices 15 and 16. Therefore the resistance of all of the resistance devices 15, 16, 17 and 18 to the flow of direct current therethrough will be the same and no current will flow through the load 10 in either direction. But a signal imparted to the control windings 55 and 59 either through the conductor 78 in the direction of the arrow 81 or through the conductor 79 in the direction of the arrow 82 will cause an unbalancing of the electrical output of the reactor 50 and 51 and thereby increase the resistance of one pair of resistance devices and proportionately decrease the resistance of the other pair of resistance devices. Direct current will then flow to the load 10 through the pair of resistance devices having the lowest resistance. If the signal is imparted to the control windings 55 and 59 through the conductor 79 in the direction of the arrow 82 the electrical output of the reactor 51 will be increased and the electrical output of the reactor 50 will be proportionately decreased with the result that the resistance of the resistance devices 15 and 16 will be decreased and the resistance of the resistance devices 17 and 18 proportionately increased. Direct current will then flow from the positive terminal 83 of the D. C. source 84 through the conductor 6, resistance device 16 in the leg 3 of the bridge circuit 1, conductor 14, load 10, conductor 12, resistance device 15 in the leg 2 of the bridge circuit 1, and back to the negative terminal 85 of the D. C. source 84 through the conductor 8. But if the signal is imparted to the control windings 59 and 55 through the conductor 78 in the direction of the arrow 81 the electrical output

of the reactor 50 will be increased and the electrical output of the reactor 51 will be proportionately decreased in which case the resistance of the resistance devices 17 and 18 will be decreased and the resistance of the resistance devices 15 and 16 increased. Direct current will then flow from the positive terminal 83 of the D. C. source 84 through the conductor 6, resistance device 18 in the leg 5 of the bridge circuit 1, conductor 12, load 10, conductor 14, resistance device 17 in the leg 4 of the bridge circuit 1, and back to the negative terminal 85 of the D. C. source 84 through the conductor 8.

The direction of flow of direct current through the load 10, and consequently the direction of rotation or movement of the load 10, is dependent upon which pair of resistance devices 15 and 16, or 17 and 18, has the higher resistance and the magnitude of the current flowing through the load 10 is dependent upon the difference in resistance between the two pair of resistance devices; and both the direction of current flow through the load 10 and the magnitude thereof are dependent upon the nature of the signal imparted to the control windings 55 and 59 of the reactors 50 and 51 respectively.

From the foregoing it will be apparent to those skilled in this art that I have provided a very simple and efficient control mechanism for accomplishing the objects of my invention.

It is to be understood that I am not limited to the specific construction shown and described herein as various modifications may be made therein within the spirit of the invention and the scope of the appended claims.

What I claim is:

1. A control mechanism of the character described comprising a bridge circuit, a source of direct current connected to said bridge circuit, two pairs of opposed variable resistance devices interposed in said bridge circuit, each of said devices comprising a compressible carbon pile and a solenoid operative to vary the compression of said carbon pile and thereby vary the resistance thereof, a shunt motor field winding connected to said bridge circuit in series with each pair of opposed variable resistance devices magnetic amplifier means, conductor means by which the said solenoids of one pair of said devices is connected to said magnetic amplifier means in parallel with each other, other conductor means by which the said solenoids of the other pair of said devices are connected to said magnetic amplifier means in parallel with each other, said magnetic amplifier means being operative in response to and in accordance with a signal imparted thereto to cause said solenoids to simultaneously decrease the compression of one pair of said carbon piles and increase the compression of the other pair of said carbon piles to thereby increase the resistance of one pair of said devices and decrease the resistance of the other pair of said devices.

2. A control mechanism of the character described comprising a bridge circuit, a source of direct current connected to said bridge circuit, four variable resistance devices each of which comprises a compressible carbon pile interposed in said bridge circuit and a solenoid independent of said bridge circuit which is operative to vary the compression of the associated carbon pile, a shunt motor field winding connected to said bridge circuit in series with two of said four variable resistance devices and also in series with the other two of said four variable resistance devices magnetic amplifier means comprising two similar saturable core reactors connected to a source of alternating current, conductor means by which the said solenoids of two of said devices are connected to one of said reactors in parallel with each other, other conductor means by which the solenoids of the other two of said devices are connected to the other of said reactors in parallel with each other, a control winding associated with each of said reactors, said control winding being operative in response to and in accordance with a signal imparted thereto to decrease the electrical output of one

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of said reactors and to proportionately increase the electrical output of the other of said reactors to thereby cause said solenoids to simultaneously decrease the compression of one pair of said carbon piles and increase the compression of the other pair of said carbon piles and thereby increase the resistance of one pair of said devices and decrease the resistance of the other pair of said devices.

3. A control mechanism of the character described comprising a bridge circuit having the legs A, B, C and D, conductor means connecting the positive terminal of a source of direct current to said bridge circuit at the junction of the legs B and D and the negative terminal of said source to said bridge circuit at the junction of the legs A and C, conductor means connecting a shunt motor field winding to said bridge circuit between the junction of the legs B and C and the junction of the legs A and D, a compressible variable resistance carbon pile interposed in each of said legs A, B, C and D, a solenoid comprising a winding and an armature associated with each of said carbon piles, said solenoids being operative to vary the compression of the associated carbon piles, magnetic amplifier means comprising two similar saturable core reactors connected to a source of alternating current, conductor means by which the windings of the solenoids associated with the carbon piles in the legs A and B are connected to one of said reactors in parallel with each other, other conductor means by which the winding of the solenoids associated with the carbon piles in the legs C and D are connected to the other of said reactors in parallel with each other, a control winding associated with each of said reactors, said control windings being operative in response to and in accordance with a signal imparted thereto to decrease the electrical output of one of said reactors and to proportionately increase the electrical output of the other

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of said reactors to thereby cause said solenoids to simultaneously decrease the compression of two of said carbon piles and increase the compression of the other two of said carbon piles and thereby increase the resistance of two of said carbon piles and decrease the resistance of the other two of said carbon piles.

4. A control mechanism of the character described comprising a bridge circuit, a load connected into said bridge circuit, two opposed compressible carbon pile variable resistance means interposed in said bridge circuit, an electrically actuated means associated with each of said carbon pile variable resistance means and operative to vary the compression of the associated carbon pile; magnetic amplifier means comprising two saturable core reactors one of which is connected to the electrically actuated means associated with one of said carbon pile variable resistance means and the other of which is connected to the electrically actuated means associated with the other of said carbon pile variable resistance means, and signal responsive control means which is operative to simultaneously decrease the electrical output of one of said reactors and increase the electrical output of the other of said reactors in response to and in accordance with a signal imparted thereto to thereby simultaneously increase the resistance of one of said carbon pile variable resistance means and decrease the resistance of the other of said carbon pile variable resistance means.

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