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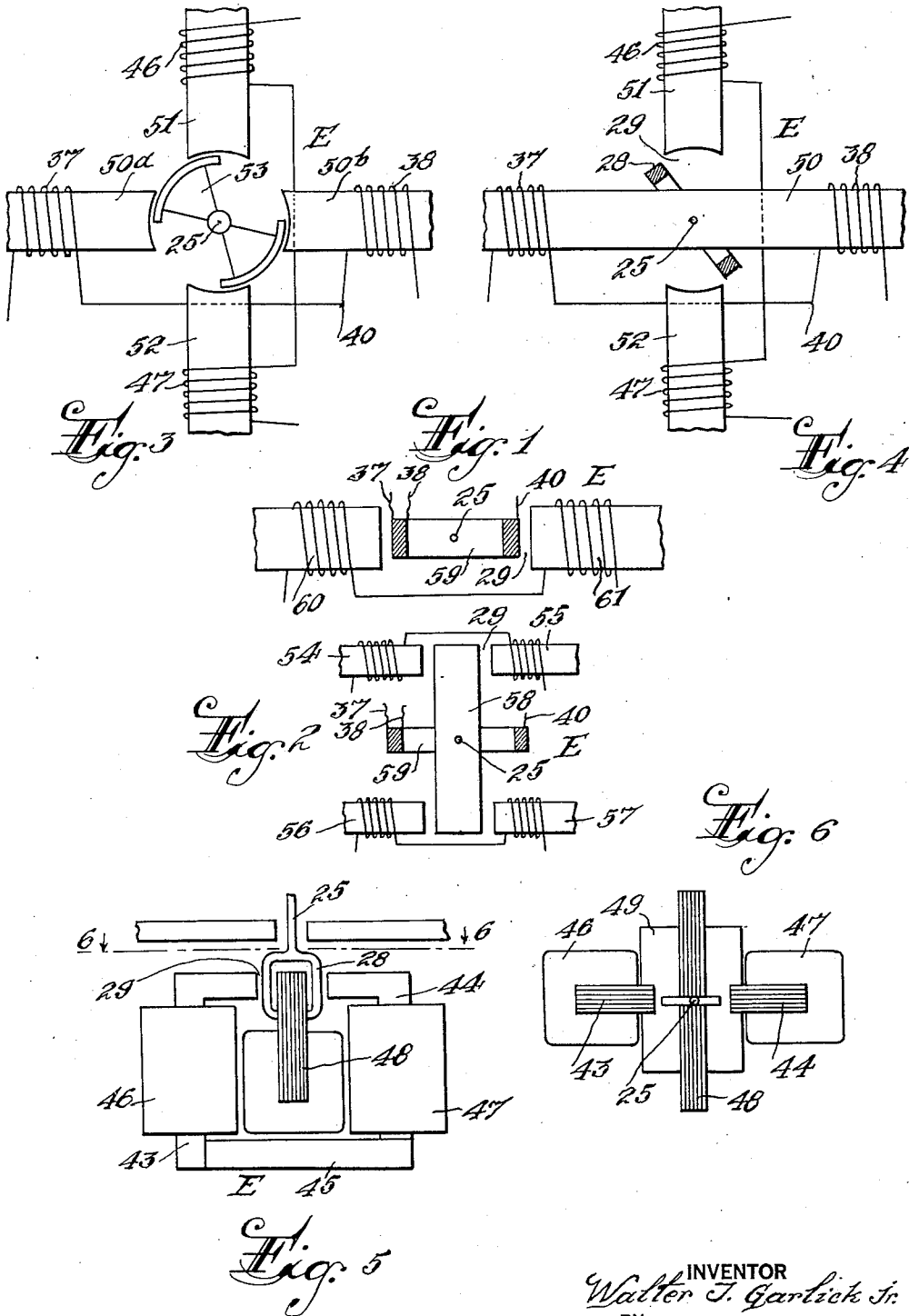
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ELECTROMAGNETIC CONTROLLING MEANS

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ELECTROMAGNETIC CONTROLLING MEANS

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This invention relates to electromagnetic means for controlling the operation of apparatus with which the said means may be associated.

In order to illustrate the application of my improved type of electromagnetic controlling means, I have chosen to illustrate it as applied to controlling the voltage of the output side of an alternating current voltage regulating mechanism wherein the voltage of this output circuit must be regulated or held at a constant value; for example, within the fraction of a volt, even though the input side may have a variation voltage of as much as 25% or even higher.

Where the output voltage from the regulator is to be held to within a fraction of a volt variation, it will be seen that the control means for the regulator must be not only very sensitive but accurate and capable of continuous use over a long period of time. To obtain this sensitive and reliable operation, I prefer to use, as a part of the electromagnetic control means, an instrument somewhat like an A. C. voltmeter with a suppressed zero, in which the moving element is restored by a spring and is proportional to the root mean square value of the current flowing through the instrument. By using such an instrument with a suppressed zero, the scale may read, for example for a 110-volt output circuit, from 109 to 111 volts. Associated with this instrument is another part of the electromagnetic control means which comprises a structure having a core of magnetic material and windings thereon, all of which cooperate with the said instrument to provide the necessary control on the voltage regulator per se.

The principal object of my invention, therefore, is to provide an electro-magnetic control means which is adapted to function with other apparatus to give a very sensitive and reliable control of the apparatus with which it is used.

Other and ancillary objects will be discerned by one skilled in this art, from a reading of the specification taken in connection with the annexed drawings, wherein:

Figure 1 is a diagram to illustrate some of the fundamental principles involved in my invention.

Figure 2 is a diagram further illustrating the different principles involved.

Figure 3 is an other diagrammatic illustration showing another form of my invention.

Figure 4 is a still further modified form illustrating certain principles involved in my invention.

Figure 5 shows a further modified form of construction.

Figure 6 is a view on the line 6-6 of Figure 5. Figure 7 is a diagrammatic illustration showing the application of my invention to a certain type of voltage regulating apparatus.

Since Figures 1 to 6 inclusive will probably be better understood after a description of Figure 7, the last will be described first in detail. In Figure 7, T illustrates a voltage regulating device based on Schermerhorn Patent 2,089,434, in which 1 is an exciting winding arranged on the core of the regulator. The core also carries windings 2 and 3, each of which has a commutator surface on which brushes operate. The brushes are carried by a connecting bar 4 which in turn is mounted on a threaded shaft 5 geared to a motor M through gears 6 and 7. One side of the motor armature is connected to one side of the output circuit to be regulated through the wire 8. The other side of the motor is connected by wire 9 to the central point of the field 10 of the motor M.

One end of the field 10 is connected to the plate 11 of a rectifier tube 12 having a grid 13 and a filament 14. The other end of the field winding 10 is connected to the plate 16 of a tube 17, similar to the tube 12. The tube 17 has a grid 18 and a filament 19. The filaments 14 and 19 are connected to a secondary winding 20 of a transformer, the primary of which is connected by leads 22 and 23 to the output circuit of the regulator. Connected to the leads 22 and 23 is the coil of an instrument 24 which is preferably of the iron vane type. The moving part of the instrument 24 is illustrated as having a shaft 25 operated between the stops 26 and 27 and carrying a short-circuited winding 28 which may be a single short-circuited turn or a plurality of short-circuited turns. The member 28 is normally positioned, when there is no change in voltage in the output circuit, in an air gap 29 between the core member 30 and another core member 31 forming part of a magnetic structure E.

The core member 31 is connected by legs 32 and 33, and arms 34 and 35 to the core member 30, thereby completing one form of magnetic structure. That part of the core 30 which carries the winding 36 is connected across the output circuit. The core legs 32 and 33 carry interconnected windings 37 and 38 which are connected at their central point 39 and by way of a lead 40 to a hold-off bias device 41. The free end of the winding 37 is connected through a grid-current-limiting resistance R_1 to the grid 13 of the tube 12, while the free end of the winding 38

is connected through the grid-current-limiting resistance R_2 to the grid 18 of the tube 17. The device 41 is connected across the output circuit of the regulator as indicated and also has a connection to the central point of the filament transformer winding 20. The central point of this winding is also connected by the lead 42 to the opposite side of the output circuit from the lead 8 running to the motor. A small condenser c is bridged across the armature of the motor M to absorb any sparking at the brushes thereof.

In the operation of the circuit diagram shown in Figure 7, it will be understood that the windings 37 and 38 which are connected in series are so wound that the fluxes generated in the legs 32 and 33 are in opposition, and when the output voltage is unvarying the coil 28 will be in a neutral position as indicated. Should the voltage on the output circuit change, this is transmitted by the instrument 24 through the shaft 25 and the short-circuited turn 28 will be shifted in the air gap 29 either to the right or left, depending on the change in the output voltage, and one of the windings 37 or 38 will generate a higher voltage than the other and thereby excite either the grid 13 or 18 of the tubes 12 and 17 accordingly, and current will then pass through the motor armature and through one portion of the field 10 and the proper tube 12 or 17, through the plate circuit thereof, and by the conductor 42 back to the output side on the circuit. The motor M will then operate to move the brushes on the windings 2 and 3 through the bar 4 of the regulator T to correct the change in voltage in the output circuit.

The tubes 12 and 17 are of the gas-filled type so that they will also respond to a shift in the phase of the current applied to their grids, as well as to the voltage. The hold-off bias 41, if used, allows a small amount of plate current to flow through the tubes 12 and 17 when the control means is in a balanced condition as indicated in Figure 7, the object being to have a certain amount of excitation in the motor so that the operation of the control means, comprising the magnetic structure with its windings and the instrument 24, will give a quicker and more sensitive change in the motor circuit.

In Figures 5 and 6 I have shown a different type of magnetic structure, in which the core members 43 and 44 are connected by a yoke member 45. The core members 43 and 44 carry windings 46 and 47 which are connected in series and across the output circuit, and correspond to the single winding 36 of Figure 7. The short-circuited turn 28 is positioned in an air gap 29 and is looped around a portion of the core member 43 carrying a winding generally referred to as 49 but which corresponds to the windings 37 and 38 of Figure 7. In this case, the short-circuited turn 28 is rotated by the shaft 25 instead of swinging as in Figure 7, but the general operation of the structure is substantially the same as that described in Figure 7.

In Figure 4 the windings 37 and 38 are arranged on a magnetic member 50 which, while shown in open circuit, is preferably in a closed circuit as in Figure 7. A short-circuited turn 28 is shown in displaced position in the air gap 29. The windings on the core members 51 and 52 correspond to the windings 46 and 47 in the structure shown in Figures 5 and 6.

Another form which the magnetic structure E may take is shown in Figure 3, in which the core member 50 is split in two portions 50a and 50b,

but the core members 51 and 52 and their respective windings 46 and 47 remain as in Figure 4. In both Figures 3 and 4 the free ends of the windings 37 and 38 are adapted to be connected to grids of tubes corresponding to 12 and 17 in Figure 7, while their common junction point is connected by a lead 40 to the device 41. In Figure 3, the moving system between the core members comprises a solid iron vane 53 carried on the shaft 25 connected to the instrument 24.

In Figure 2 the core members 54 and 55 carry windings corresponding to windings 46 and 47; likewise the core members 56 and 57 carry similar windings. In the air gap 29 between these core members there is positioned a magnetic shunt 58 pivotally mounted on the shaft 25, along with a coil 59 carrying two windings corresponding to the windings 37 and 38, which windings are connected by the common junction wire 40 to the device 41 as in Figure 7.

In Figure 1 the coil 59 is similar to that shown in Figure 2, but is pivoted to rotate with the shaft 25 between the magnetic core members 60 and 61.

Referring to the somewhat diagrammatic illustrations of Figures 1, 2, 3 and 4, it is to be understood that the core members outside of the air gap 29 preferably have closed magnetic circuits.

Figures 1 to 4 inclusive illustrate different forms which the magnetic structure E may take for the voltage regulator arrangement shown in Figure 7, but I prefer to use the form of structure shown in Figure 5 or Figure 7.

While the electromagnetic controlling means which I have described provides excellent and close regulation in an electrical circuit arrangement, such as shown in Figure 7, I do not wish to be unduly limited in the application to which my invention may be put, as the instrument 24 may be actuated by other means than the output circuit of the regulating system shown and described, or the short-circuited winding in the air gap 29 of the electromagnetic structure E may respond to the movement of another instrument equivalent to a voltmeter or instrument 24, and it will therefore be obvious that various changes may be made in the details without departing from the spirit of my invention or the scope of the appended claims.

What I claim is:

1. Electromagnetic controlling means including a structure of magnetic material having a gap in a portion thereof, a short-circuited conductor positioned around a part of the magnetic structure and located in said gap, an exciting winding on the magnetic structure for sending flux through the gap in which the short-circuited conductor is located, windings on another part of said structure around which said short-circuited conductor is located, said last-mentioned windings being connected so the fluxes set up thereby are in opposition, the said windings adapted to be connected to devices sensitive to changes such as potential, phase relation or a combination of both potential and phase, for example the grids of control tubes, and a voltmeter connected across a circuit to be controlled, the moving element of the meter having a member carrying said short-circuited coil for moving the same to change the potential in said last-mentioned windings for the purpose described.

2. An electromagnetic control means including a magnetic core structure having an air gap in a portion thereof, a winding on a portion of the core structure for normally sending magnetic flux through said air gap, a short-circuited wind-

ing located in said air gap, other windings on other parts of said core structure and connected so as to neutralize each other when said winding located in the air gap is in a neutral position, but one of said other windings being capable of generating a higher potential than the other winding of said last-mentioned windings when the gap coil is moved out of neutral position, and an instrument responsive to changes that are to be regulated forming part of said control means for moving said gap winding to cause a shift of flux in the magnetic structure via the air gap so one of said other windings develops a higher potential and phase shift than its companion winding for acting on a regulating mechanism.

3. An electromagnetic control means including a magnetic core structure having an air gap in a portion thereof, a winding on a portion of the core structure for normally sending magnetic flux through said air gap, a member movably mounted in the air gap and being capable of changing the flow of flux through the air gap, windings associated with said movable gap member so as to generate a voltage in the windings capable of acting on a regulating mechanism, and an instrument connected to move said movable gap member, said instrument forming part of said control means and being responsive to changes that are to be regulated.

4. Translating means for converting changes, such as voltage variations in an electrical output circuit, into electromechanical work to regulate said changes, said translating means including a magnetic core structure having an air gap in a portion thereof, a winding on a portion of the core structure for normally sending magnetic flux through said air gap, a member movably mounted in the air gap and being capable of changing the flow of flux through the gap, windings positioned on the core so as to have a voltage generated therein when said member moves in the air gap, means connected to said last-mentioned windings and responsive to said voltage changes therein for causing an electromechanical mechanism inter-connected between an input circuit and said output to move to correct changes in voltage in the output circuit, and an instrument electrically connected to said output circuit and responsive to the voltage changes therein and comprising part of said translating means and connected so as to move said member in the air gap.

5. Translating means for converting changes, such as voltage variations in an electrical output circuit, into electromechanical work to regulate said changes, said translating means including a magnetic core structure having an air gap in a portion thereof, a winding on a portion of the core structure for normally sending magnetic flux through said air gap, a member movably mounted in the air gap and being capable of changing the flow of flux through the gap, windings positioned on the core so as to have a voltage generated therein when said member moves in the air gap, electronic tubes preferably of the gas-filled type having their respective grids connected to said last-mentioned windings which have a common connection to one side of the output circuit, a motor having its field winding connected to the plates of said tubes while the filaments thereof are connected to one side of the output circuit, the opposite side of which is connected to the center of the motor field winding through the motor armature; a voltage regulator operated by the motor inter-connected be-

tween an input circuit and the output circuit, and an instrument electrically connected to said output circuit and responsive to the voltage changes therein and comprising part of said translating means and connected so as to move said member in the air gap.

6. Translating means for converting changes, such as voltage variations in an electrical output circuit, into electromechanical work to regulate said changes, said translating means including a magnetic core structure having an air gap in a portion thereof, a winding on a portion of the core structure for normally sending magnetic flux through said air gap, a short-circuited winding positioned in said gap and an instrument forming part of said translating means and having a part moved by a winding of the instrument and mechanically carrying said short-circuited winding, said instrument winding being electrically connected and responsive to changes in voltage in said output circuit, windings positioned on the core structure so as to have voltages set up therein when said winding in the air gap is moved by said instrument-movable part, an electromechanical mechanism inter-connected between an input circuit and said output circuit, and means, connected to the windings on the core structure and responsive to the voltages set up therein on movement of the gap winding, for causing said electromechanical mechanism to move to correct changes in the voltage in said output circuit.

7. Electromagnetic control means for the purpose described comprising, a magnetic core structure having an air gap in a portion thereof, an exciting winding on the core for sending flux through said gap, a movable member positioned in said air gap, an instrument having a movable part mechanically connected to said member in the air gap, said instrument having a winding for moving said part and the winding being connected and responsive to voltage changes in a circuit whose voltage is to be regulated, a regulator of the type described to regulate the voltage of an output circuit connected to the regulator, means capable of operating the regulator, and windings associated with the core structure so movement of said member in the air gap will cause voltages to be set up in these windings, the terminals of which are connected to said regulator operating means.

8. Electromagnetic control means for the purpose described comprising, a magnetic core structure having an air gap in a portion thereof, an exciting winding on the core for sending flux through said gap, a movable member positioned in said air gap, means for moving said member in the air gap, said means being responsive to changes in a mechanism whose changes are to be regulated, a regulator to regulate the changes in said mechanism, means capable of operating the regulator, and windings associated with said core structure so movement of said member in the air gap will cause voltages to be set up in these windings, the terminals of which are connected to said regulator operating means.

9. Translating means for converting changes, such as voltage variations in an electrical output circuit, into electromechanical work to regulate said changes, said translating means including a magnetic core structure having an air gap in a portion thereof, a winding on a portion of the core structure for normally sending magnetic flux through said air gap, a member movably mounted in the air gap and being capable of

changing the flow of flux through the gap, wind-
ings positioned on the core so as to have a voltage
generated therein when said member moves in
the air gap, electronic tubes having their re-
5 spective grids connected to said last-mentioned
windings which have a common connection to one
side of the output circuit, a motor having its
field winding connected to the plates of said
tubes while the cathodes thereof are connected
10 to one side of the output circuit, the opposite side
of which is connected to the center of the motor
field winding through the motor armature, said

tubes being of a type which will normally pass a
small amount of current through their plate cir-
cuits and thereby excite the field of the motor
to a certain degree for the purpose described, a
voltage regulator operated by the motor inter- 5
connected between an input circuit and the out-
put circuit, and an instrument electrically con-
nected to said output circuit and responsive to
the voltage changes therein and comprising part
of said translating means and connected so as to 10
move said member in the air gap.

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