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J. L. CREVELING

2,233,772

ELECTRIC SYSTEM

Original Filed March 12, 1935

Fig. 1.

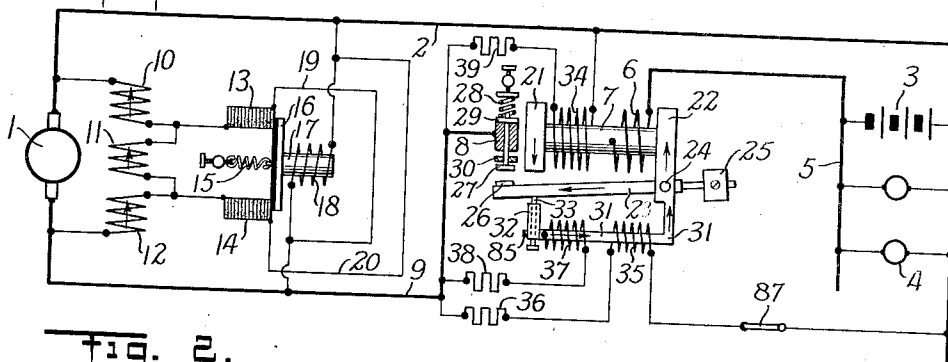


Fig. 2.

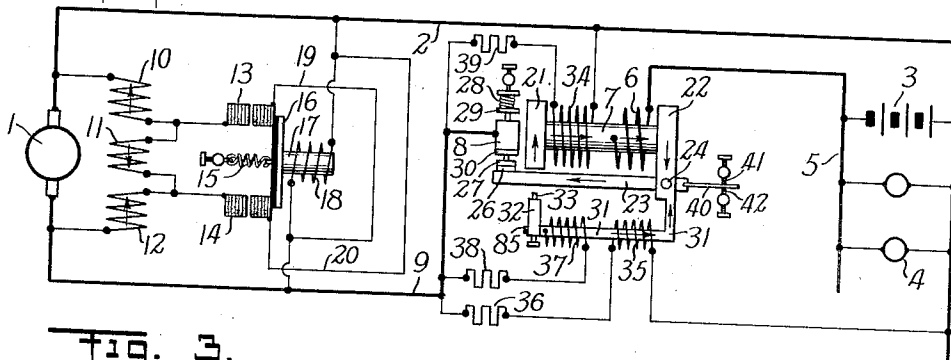


Fig. 3.

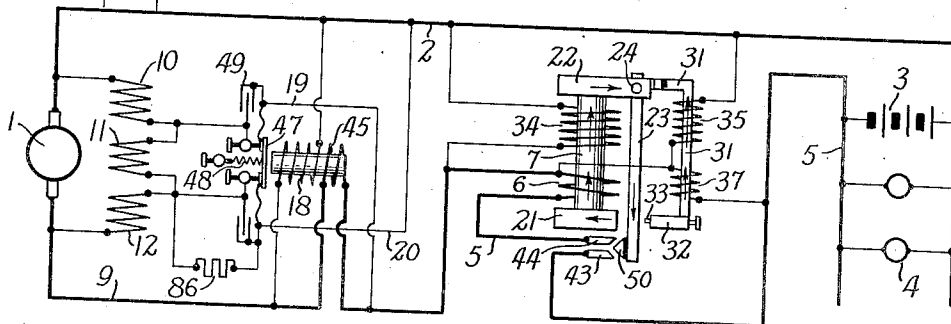
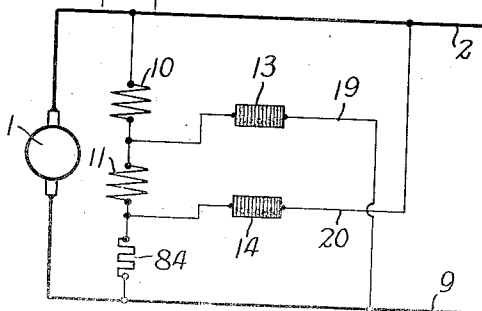


Fig. 4.



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ELECTRIC SYSTEM

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Original application March 12, 1935, Serial No. 10,646. Divided and this application August 17, 1938, Serial No. 225,283

11 Claims. (Cl. 171—223)

My invention pertains to that class of electric systems wherein a dynamo or other controllable source of potential difference is to be regulated automatically throughout tendencies to vary.

This application is a division of my co-pending application Serial No. 10,646, filed March 12, 1935, and entitled "Electric systems," which has materialized into Patent No. 2,133,976.

As a dynamo driven at variable speed and employed to charge a storage battery and operate lamps or other translating devices is a widely used type of system to which my invention is particularly applicable, it will be described with respect to such a system.

An object of my invention is to provide means whereby the source of potential difference may be regulated automatically within relatively very narrow limits throughout wide range of tendency to vary.

Another object is to provide means whereby the source may be connected automatically with the circuit to be supplied whenever able to supply the same and disconnected therefrom whenever unable to perform this function.

Another object is to provide means for connecting the source with a load, including a variable counter-electromotive force, at such times as the source has the instant voltage of said counter-electromotive force, and to cause disconnection at substantially such time as the voltage of the source and the counter-electromotive force are practically equal.

Another object is to provide simple, reliable and rugged means for attaining the above objects. Other objects will be in part obvious and in part pointed out below.

The invention accordingly consists in the features of construction, combination of elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the drawing:

Figure 1 is a diagrammatic representation of one type of system comprehending my invention, the source of current and its load being disconnected;

Figure 2 is a representation similar to Figure 1, but showing the source of current connected to the load; and

Figures 3 and 4 are representations of modified forms of my invention.

In the drawing, referring particularly to Figure 1, 1 represents a dynamo or generator hav-

ing one of its brushes connected as by wire 2 with one side of the storage battery 3 and lamps or other translating devices indicated at 4.

The other terminals of the lamps and battery are indicated as connected with the wire 5, which is led to one end of the coil 6 wound about the core 7 with which its opposite end may be connected, as shown. Coil 6 and core 7 are elements of means for connecting the dynamo and its load (to be more fully described later), comprising a member 8, insulated from 6 and 7, and connected by wire 9 with the remaining brush of the dynamo.

The dynamo 1 is shown as provided with a plurality of field windings 10, 11 and 12. The winding 10 has one terminal connected with the wire 2 and its other terminal connected with one end of a regulating device, in this instance indicated as a carbon pile 13, having its opposite end in electrical connection with the wire 9, as by wire 19. The winding 12 has one terminal connected with the wire 9, and its opposite terminal connected with a regulating device (indicated as a carbon pile 14), having its remaining terminal connected with the wire 2, as by wire 20. The winding 11 is shown as connected across the ends of windings 10 and 12, between the coils and piles 13 and 14. A spring 15, acting upon the yoke 16, insulated from the piles as shown, tends to compress the piles and lower their resistance; while the core 17, when attracted by the coil 18 across wires 2 and 9, tends to increase the resistance of the piles.

The previously mentioned core 7 is of iron or other magnetic material and is provided with a pole piece 21, a yoke 22 and armature 23, pivoted as at 24, and which may be counter-balanced to any degree desired, as by counterweight 25. Attraction between pole piece 21 and armature 23 tends to raise the free end of the armature and bring the contact member 26 into contact with a similar member 27, provided with a stem which is indicated as pressed downwardly by an adjustable spring 28. The downward travel of 27 is limited by the nut 29, while its upward travel against the effort of spring 28 is limited by nut 30.

The yoke carries an extension 31, provided with a pole piece 32, which may be adjustably secured thereto as by screws 35 passing through slots (not shown) in 32 and permitting the same to be raised or lowered and held in position, in a well known manner. Extension 31 and pole piece 32 are of magnetic material, and 31 is shown as provided with a screw 33, limiting the downward movement of armature 23, and this 55

screw is, of course, of non-magnetic material. The core 7 is provided with a voltage winding 34 across the wires 2 and 9 through an adjustable resistance 39. The extension 31 is provided with a voltage winding 35 across wires 2 and 9 through a suitable adjusting resistance 36, if desired. 31 is also provided with a voltage winding 37, indicated as having one end connected with the said member 31 and the opposite end with wire 9 through an adjusting resistance 38, if desired. As one end of coil 6 is connected with the core 7, coil 37 is therefore, in effect, across the "break" between contact members 26 and 27, it being noted that in this figure the switch is open and the dynamo and battery disconnected.

In Figure 2, substantially the same instrumentalities are shown as in Figure 1, though in a different phase of operation, the only structural difference being that the counter-weight 25 is indicated as replaced in Figure 2 by a leaf spring 40, which may have its effect upon the armature 23 adjusted by screws 41 and 42. In this figure, the switch is shown in its closed position, connecting the dynamo with its load, and the carbon piles 13 and 14 are in the extreme position of being open-circuited, to more plainly bring out the operation of coils 10, 11 and 12.

In Figure 3, the carbon piles of Figures 1 and 2 are indicated as replaced by vibratory contacts affected by an armature 47, supported in a suitable manner (not shown), drawn toward the left by the adjustable spring 48 and toward the right by magnetization of the core 46, surrounded by the voltage winding 18 and series or current winding 45. The contacts may be shunted, of course, by condensers 49, resistances as shown at 86, or both, if desired, as is usual practice with this well known general type of device. In this figure, the wire 5 is carried to the contact member 43, and from the companion member 44 to the end of coil 6, which is "grounded" in Figures 1 and 2 to indicate that the switch may be of either the single or double break variety, as desired. The armature 23 carries an insulated contact bridge 50, and the entire mechanism is shown in a position revolved 90 degrees from that of Figures 1 and 2, so that the armature 23, under gravity alone, would tend to take a vertical position between pole pieces 21 and 32. The member 31 is indicated as having an air gap or a non-magnetic insert between its end and member 22, which may be employed, if desired.

In Figure 4, coils 10 and 11 are shown as in Figures 1 to 5, while coil 12 of these figures is replaced by a resistor 84.

An operation of my invention is substantially as follows, referring first to Figure 1:

If the dynamo 1 be at rest, the lamps or translating devices 4 may be operated by the battery 3, in an obvious manner. If the upper brush of dynamo 1 be the negative, it will, of course, be connected with the negative side of the battery by wire 2, and the positive leg of the dynamo circuit will be broken at the contacts 26—27. A very feeble current will be shunted around the break through wire 5, coil 6, core 7, yoke 22, member 31 and coil 37, resistor 38, wire 9, dynamo 1 and wire 2 to battery 3. Coil 37 is of relatively high resistance on account of a large number of turns obtained by using fine wire, and, therefore, its current consumption may be neglected in practice. This coil is here indicated as so wound as to tend to set up a magnetic flux in the direction of the arrow thereon, and also through the

members 31, 22, 7 and 21, in the directions indicated. By proper adjustment of air gaps between armature 23 and pole pieces 21 and 32, as may be accomplished through adjustment of the position of pole piece 32 and screw 33, the above mentioned excitation of coil 37 may be caused to firmly hold the armature 23 in the position indicated and insure maintenance of the break at 26—27, in a well known manner, so long as current flows from the battery through the dynamo and coil 37, as above outlined.

Now, if the dynamo be started and its speed gradually increased, its residual magnetism will cause a slight current to flow from the positive brush through coil 12, pile 14, wire 20 and wire 2 to the negative brush. Current will also flow from wires 9 and 19, pile 13 and coil 10, to wire 2 and also from wire 9 through wire 19, pile 13, coil 11, pile 14 and wire 20 to wire 2. And, if these coils 10, 11 and 12 are properly wound, they will all assist in building up the dynamo field and cause the dynamo to reach its normal voltage as soon as its so-called "critical" speed is reached.

Assuming that the piles 13 and 14 have negligible resistance until affected by coil 18, which condition is usually sought and nearly obtained in practice, and the coils 10, 11 and 12 so wound as to tend to set up fluxes in the direction of the arrows thereupon, it will be noted that the said coils are, in effect, all in multiple across the dynamo terminals and all working together to build up a strong field and permit the voltage of the dynamo to reach the battery voltage at as low speed as possible. As the dynamo voltage increases from zero, the current flowing back from the battery through the dynamo and coil 37 will, of course, diminish and equal zero when the dynamo and battery are at equal voltages, at which time coil 37 will cease tending to hold the armature 23; whereas, should the dynamo voltage exceed that of the battery, the current in this coil will reverse and tend to cause a flux in the reverse direction to that indicated by the arrow in Figure 1.

Further, as the dynamo voltage increases from zero, current in proportion thereto will flow through coils 34 and 35, which may be so wound as to tend to set up fluxes as indicated by the arrows thereupon in Figure 2. By properly dimensioning the strength of these coils, which may be adjusted by means of resistors 36 and 39 (which may be in the form of adjustable resistors, if desired), and by properly adjusting the position of the armature 23 with respect to the pole pieces 21 and 32, I cause the armature 23 to be raised and close the contacts 26—27, as shown in Figure 2, when the dynamo voltage and the battery voltage are substantially equal or when either voltage is very slightly in excess of the other, as may be considered desirable. As the dynamo rises above this point, current will be supplied by the dynamo in a well-known manner, and by flowing through coil 6, assist coil 34 in raising armature 23 against the action of spring 28 so as to reduce the airgap between 23 and 21 to the limit determined by nut 30, to cause a heavy pressure upon the contact and low resistance thereof. While the dynamo is active, current will flow through the coil 18, and this and its cooperating instrumentalities may be so arranged as to control the pressure upon the piles 13—14, in such manner as to prevent the dynamo voltage varying from a preselected value within very narrow limits throughout any tendency to

vary, as upon speed changes, in a manner now well-known in the art, provided the decrease in pressure upon the piles decreases the field excitation of the dynamo, and vice versa.

5 That this condition is fulfilled will be plain from Figure 2, wherein an extreme case is illustrated for sake of simplicity and the piles 13—14 indicated as having the pressure thereupon reduced to the point of opening the circuits there-
10 through. Here it will be noted that the coils 10, 11 and 12 are now in series with each other across the dynamo and that coil 11 has its effect reversed so as to "buck" the other coils instead of "boost," as when the dynamo was operating at
15 low speed. It will be plain that, at a point between these limits, the current in coil 11 will have zero value and that the coils may be shifted from shunt to series relation with respect to each without opening their circuits. Further, it will
20 be seen that by properly proportioning the coils 10, 11 and 12, the field may be weakened to any desired extent without reaching the unstable range of the carbon piles and that the field may even be reversed, if desired. As the dynamo
25 speed falls from a high value, coil 13 will so control the field as to hold the voltage substantially constant until the speed sinks below the point where full field will accomplish this, and then the current delivered by the dynamo will fall to
30 zero and the contact at 26—27 may be caused to open at this point or upon very slight back discharge through coil 6, whereupon further fall in dynamo voltage will cause the current in coil 37 to set up the flux shown in Figure 1 and hold
35 the switch open.

The operation of the system as shown in Figure 3 is substantially the same as above described with respect to Figures 1 and 2, save that a vibratory contact device instead of a carbon pile is
40 used to control the field coils 10, 11 and 12, and this is shown as controlled by a voltage coil 18 and a series or current coil 45 which modifies the operation in a manner now well known in the art, and which is shown merely to indicate
45 that the field regulator may be responsive to voltage, to current, or to both, as desired. In this figure, the "single break" contacts 26 and 27 are replaced by the "double break" contacts 43—44—50, insulated from the armature so that
50 the same does not carry any current while the inter-action of the windings is modified by a non-magnetic member inserted between 22 and 31. The effects of these changes are so well known that it is believed further description of
55 the operation at this point would be superfluous. With the armature 23 having a normally vertical mid-position, as shown in this figure, if it is released from one extreme position it will naturally tend to swing past the mid-position to very
60 close to the opposite extreme, and, therefore, when released, may be drawn in one extreme or the other upon very slight differences in voltage above or below the instant voltage of the battery.

In Figure 4, coils 10 and 11 are shown as in
65 the prior figures, while coil 12 is indicated as replaced by a resistance 84, which, of course, might replace coil 10, instead, with the same result, if the parts be properly proportioned. With this arrangement, coils 10 and 11 may be weakened,
70 and then coil 11 may be reversed upon suitable increase in the resistance of piles 13—14, in a manner that will be plain from the foregoing.

From the foregoing it will be noted that many types of apparatus may be used in the employ-
75 ment of my invention and many given types of

devices with different connections and proportions and adjustment of the parts may be used to employ the invention, even though the individual effects of the parts may differ widely.

The various arrangements of field coils indicated are believed to be sufficient for illustration
5 as it is plain that an indefinite number of relative values may be given to the parts shown to produce an indefinite number of precise net results, and that many changes in details of the regulating devices may be made without departing from
10 the spirit of the invention.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be
15 varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting
20 sense.

It will thus be seen that I have provided a practical and efficient system and apparatus for accomplishing the several objects hereinabove
25 mentioned as well as many others in a successful manner.

I claim:

1. In apparatus of the class described, the combination of, an armature, a field for said
armature including three electrical units con-
30 nected in series across said armature, two independent electrical circuits one of which is connected upon each side of the center one of said units, and control means associated with said
two electrical circuits to reverse the current of
35 said center one of said units.

2. In electrical apparatus, an armature, a first field winding having one side connected to one
side of said armature and the other side connected through a first control unit to the other
40 side of said armature, a second field winding having one side connected to said other side of said armature and the other side connected through a second control unit to said first side of said
armature, a third field winding connected across
45 said other sides of said first and second field windings, and means to regulate said control units dependent upon the electrical conditions of the circuit of said armature.

3. In electrical apparatus, an armature, a first
50 field winding having one side connected to one side of said armature and the other side connected through a first control unit to the other side of said armature, a resistance unit having
one side connected to said other side of said
55 armature and the other side connected through a second control unit to said first side of said armature, and a second field winding connected across said other sides of said first field winding
and said resistance unit.
60

4. In apparatus of the class described, the combination of, an armature, a field for said armature including three electrical units connected in series
across said armature, two independent electrical
65 circuits one of which is connected upon each side of the center one of said units, and control means associated with said two electrical circuits to reverse the current of said center one of said units, said control means comprising two vibratory contact units one of which is connected in each of
70 said electrical circuits and a solenoid unit to exert control upon said vibratory contact units.

5. In apparatus of the class described, the combination of, an armature, a field for said armature including three electrical units connected in
75

- series across said armature, two independent electrical circuits one of which is connected upon each side of the center one of said units, and control means associated with said two electrical circuits to reverse the current of said center one of said units, said control means comprising two carbon piles one of which is connected in each of said electrical circuits and a spring solenoid unit mechanically connected to regulate the resistance of said carbon piles.
6. In apparatus of the class described, the combination of, an armature, a field for said armature including three electrical units connected in series across said armature, two independent electrical circuits one of which is connected upon each side of the center one of said units and is shunted across one of the outside ones of said units, and control means associated with said two electrical circuits to vary the effective resistance thereof and thereby reverse the current through the center one of said units.
7. In apparatus of the class described, the combination of, an armature, a field for said armature including three electrical units connected in series across said armature, the center one of said units and another of said units normally cooperating in setting up flux, two independent electrical circuits one of which is connected upon each side of the center one of said units, each of said electrical circuits including a variable resistance element, and control means to regulate the resistance of said resistance elements to reverse the current in said center one of said units.
8. In apparatus of the class described, the combination of: an armature; a field for said armature including three electrical units designated respectively as first, second, and third units; circuit means connecting said units in series, with one side of said first unit connected to one side of said armature, and one side of said third unit connected to the other side of said armature; two independent electrical circuits one of which is connected from the juncture of said first and second units to said other side of said armature, and the other of which is connected from the juncture of said second and third units to said one side of said armature, each of said independent electrical circuits including a current controlling means; and control means associated with said independent electrical circuits to regulate said current controlling means and gradually change the amounts of current flowing through said independent circuits from maximum value to substantially zero value.
9. In apparatus of the class described, the combination of, an armature, a pair of power lines connected across said armature, a field for said armature including three electrical units designated respectively as first, second, and third units, said second unit being at least a portion of the field winding for said armature, circuit means connecting said units in series with one side of said first unit connected to one of said power lines and one side of said third unit connected to the other of said power lines and with said second unit connected between said first unit and said third unit, two independent electrical circuits one of which is connected from the juncture of said first and second units to said other of said power lines and the other of which is connected from the juncture of said second and third units to said one of said power lines, each of said independent electrical circuits including a current-controlling means to regulate the current flowing therethrough, and means to regulate said current-controlling means to gradually change the current flowing through said independent circuits from maximum value to substantially zero value.
10. In apparatus of the class described, the combination of, an armature, a pair of power lines connected across said armature, a field for said armature including three electrical units designated respectively as first, second, and third units, said second unit being at least a portion of the field winding for said armature and said third unit comprising a fixed impedance producing no field flux, circuit means connecting said units in series with one side of said first unit connected to one of said power lines and one side of said third unit connected to the other of said power lines and with said second unit connected between said first unit and said third unit, two independent electrical circuits one of which is connected from the juncture of said first and second units to said other of said power lines and the other of which is connected from the juncture of said second and third units to said one of said power lines, each of said independent electrical circuits including a current-controlling means to regulate the current flowing therethrough, and means to regulate said current-controlling means to gradually change the current flowing through said independent circuits from maximum value to substantially zero value.
11. In apparatus of the class described, the combination of, an armature, a field for said armature including three electrical units connected in series across said armature, two independent electrical circuits one of which is connected upon each side of the center one of said units, and control means associated with said two electrical circuits to reverse the current of said center one of said units, said control means comprising a pair of variable impedance units one of which is connected in each of said independent electrical circuits and a solenoid-spring unit including an armature which is biased in one direction by a spring and which is drawn in the other direction by a solenoid which is connected across said armature.

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