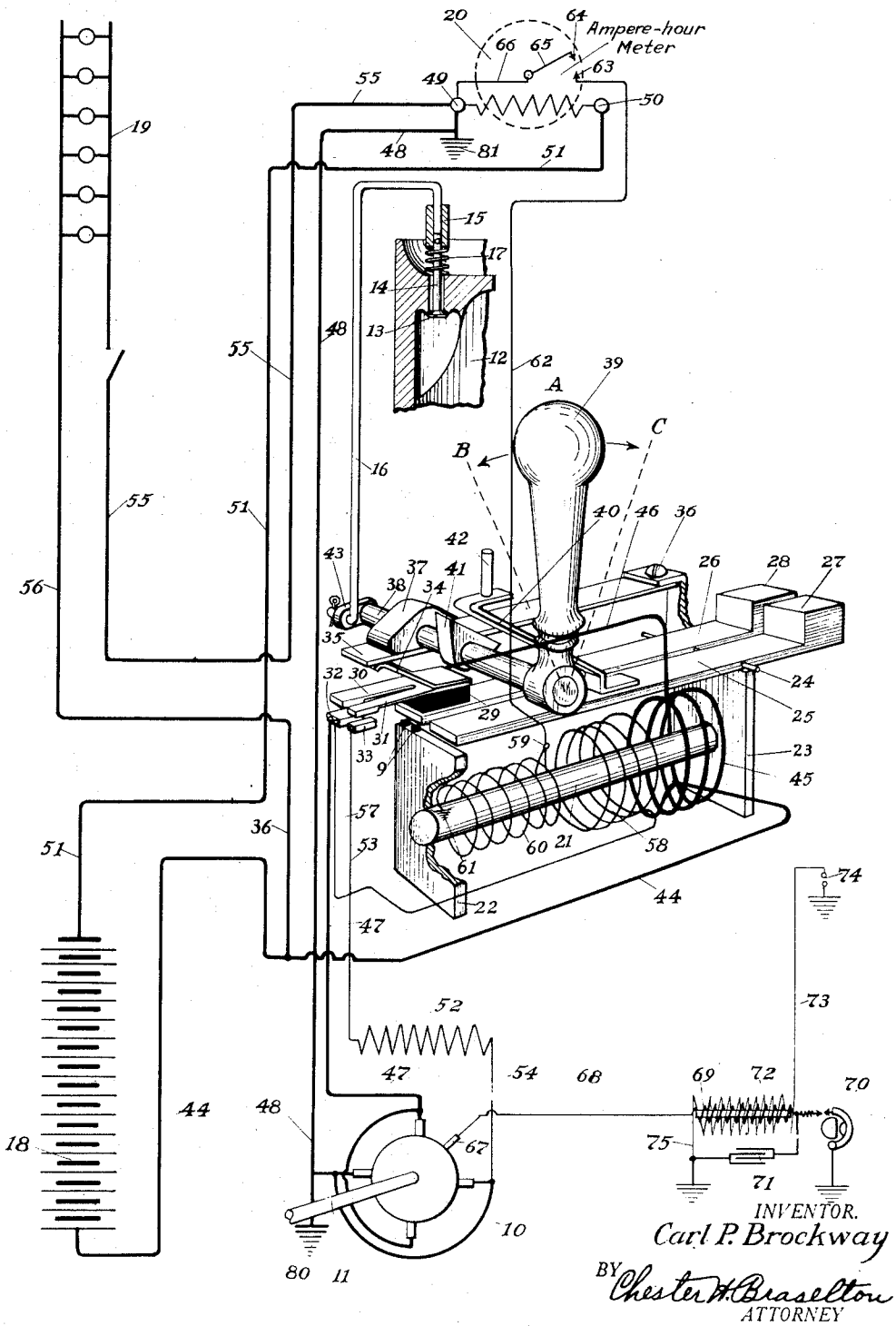
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ELECTRIC SYSTEM FOR GENERATING UNITS

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ELECTRIC SYSTEM FOR GENERATING UNITS.

Application filed April 28, 1919. Serial No. 293,261.

To all whom it may concern:

Be it known that I, CARL P. BROCKWAY, a citizen of the United States, residing at Toledo, in the county of Lucas and State of Ohio, have invented certain new and useful Improvements in Electric Systems for Generating Units, of which I declare the following to be a full, clear, and exact description.

This invention relates to improvements in controlling means for electric generating systems, in which electric current is drawn from a dynamo-electric machine driven by a gas engine, and the surplus current not needed for the load is stored in a secondary battery. When it is desired to start the engine, the dynamo-electric machine is used as a motor to turn the crank shaft of the engine, drawing current for the purpose from the storage battery. In its more essential aspects, the system here shown is similar to that disclosed in my co-pending application, Serial Number 288,570, filed April 8, 1919.

The principal object of the present invention is the provision of means for breaking the main circuit between the battery and dynamo-electric machine, when, after the starting lever is moved to starting position, the engine shaft fails to turn, as would occur should the piston stick in the cylinder.

Another object of the invention is the provision of means for closing and opening the switch rapidly, thus eliminating all unnecessary heating of the switch contacts.

Still another object of the invention is the provision of a novel connection between the switch operating means and the compression relief valve of the engine.

Other objects, and objects relating to details of construction and economies of manufacture, will appear as I proceed with the description of that embodiment of the invention, which, for the purposes of the present application, I have illustrated in the accompanying drawing, which is a diagrammatic illustration showing apparatus and connections embodying my invention.

The system illustrated is semi-automatic, that is, it is designed so that the engine must be started by the operator, but will be stopped automatically when the storage battery has reached a predetermined state of charge. There is a provision however, for stopping the engine manually, should the operator desire to do so. In the drawing, 10 indicates a dynamo-electric machine to which the crank shaft 11 of a gas engine is directly connected. A fragment of the engine cylinder is shown at 12. The cylinder head contains a compression relief valve 13, mounted upon a valve stem 14, which has fixed thereto a guide sleeve 15 for the end of a valve operating rod 16. A spring 17 mounted between the cylinder head and the sleeve 15 tends to hold the valve 13 closed. A storage battery is diagrammatically indicated at 18, while an electric load, illustrated as a bank of lamps, is shown at 19. For accomplishing the automatic stopping of the engine, when the battery is fully charged, I may employ a measuring instrument, which preferably is an ampere-hour meter indicated at 20.

The control means, in which is to be found most of the novel elements of the present invention, will now be described. At 21 is shown the core, and at 22 and 23 the pole pieces of an electro-magnet. Just above the pole piece 23 is located a pin 24, upon which are separately pivoted an armature 25 of great magnetic permeability, and an armature 26 of lesser permeability. Weights 27 and 28 tend to lift the forward ends of the armatures 25 and 26 respectively. Upon the forward end of the armature 26 is a block 29 of insulation, which carries a pair of spring contacts 30 and 31, adapted to engage fixed contacts 32 and 33. The contact 31 is bent down so as to reach contact 33 before the contact 30 reaches the contact 32.

Above the base of the spring contacts 30 and 31 is secured an upwardly extending spring finger 34, which at its upper end bears against the lower surface of a spring metal arm 35, fastened at its rear end by a screw 36 to the container for the control apparatus. The arm 35 normally bears against the flat face of a cam 37, which is secured to a rock shaft 38, and thereby tends to hold the rock shaft, together with its handle 39, in the position illustrated in the drawing. A stop arm 40 is secured to the armature 25 and extends forward, and partially above, a second cam 41, also secured to the rock shaft. In the normal position of the rock shaft, the stop arm 40 is not engaged by the cam 41, but when the handle

39 is thrown to either of its extreme positions, indicated by the dotted lines in the drawings, one of the points of the cam contacts with the under surface of the stop arm 40, and thereby holds the armature 25 in the elevated position shown in the drawing. However, when the handle 39 is in the neutral position, this armature may be depressed manually by pressure applied to the top of a push pin or button 42.

At the end of the rock shaft, opposite the handle 39 is a short crank arm 43, in which is pivotally carried the lower extremity of the valve operating rod 16. As will be evident from an inspection of the drawing, the movement of the handle 39 from the neutral position marked "A" in the drawing, to the position marked "B," at the same time that it depresses the contacts 30 and 31, holds the armature 25 in elevated position, and pulls downward upon the rod 16, opening the valve 13 against the action of the spring 17. When the handle is moved back to neutral, the valve is closed by the action of the spring 17. As the handle is moved from neutral to position marked "C" in the drawing, the spring arm 35 is again depressed, again rocking down the contacts 30 and 31, if they have risen in the meantime, and the cam 41 raises stop arm 40, if it has been depressed in the meantime, and the rod 16 is raised, sliding freely in the sleeve 15, and not affecting the valve.

The principal electric circuit of the system is that which connects the dynamo-electric machine 10 with the storage battery 18. From the latter a wire 44 leads to a series coil 45, surrounding the core 21 of the electro-magnet. Thence a wire 46 extends to the contacts 30 and 31. From the fixed contact 32, a wire 47 leads to the positive brushes of the dynamo-electric machine 10. From the negative brushes a wire 48 leads to one terminal 49 of the ampere-hour meter 20. The internal circuits of the meter are connected between the terminals 49 and 50, and from the latter terminal a wire 51 leads back to the battery 18. The field 52 of the dynamo-electric machine is connected by wire 53 to fixed contact 33, and by wire 54 with the negative brushes of the dynamo-electric machine. The electric load 19 is connected between the wire 55, which extends to the terminal 49 of the ampere-hour meter, and wire 56, which is joined to the wire 44. From the fixed contact 32, a wire 57 leads to a coil 58, which in turn is connected at 59 with a coil 60, the latter being connected to ground at 61. From the point 59 a wire 62 leads to a contact point 63, located on the face of the meter dial at the point indicating a full charge of the storage battery. The contact 63 is adapted to be engaged by a contact 64 carried by the meter hand 65. The pivot of the hand 65 is joined by a short wire 66 with the meter terminal 49. Small projections 9 of a non-magnetic material are interposed between the pole piece 22 and the armature 26, to prevent them from coming into close engagement with each other.

Ignition for the engine is taken from an auxiliary or third brush, 67, through a wire 68, to which the primary winding 69 of the ignition coil is connected. The other end of the winding is connected through a timer 70 to ground, and also through a condenser 71 to ground, for the purpose of reducing sparking across the timer contacts. The secondary winding 72 is connected through the wire 73 to ground through a spark plug 74 in the engine, and at the other end through a wire 75 directly to ground.

Operation.

Assuming that the ampere-hour meter shows that the battery is in need of recharging, the operator grasps the handle 39 and throws it to position B momentarily only, or long enough simply to enable the machine 10, acting as a motor, to get under way without the load made by the engine compression. Then he throws the handle 39 to position C, in which position the valve 13 is closed, and here, if all conditions are correct, the engine should begin firing, when the handle 39 may be released, whereupon the spring arm 35 acting upon the cam 37 will return the handle to neutral position. The contacts 30, 32 and 31, 33, will remain engaged, however, because of the action of the electro-magnet. If it should so happen that for some reason the crank shaft of the engine could not turn, as for instance because of the sticking of the piston in the engine cylinder, the unusually heavy surge of current from the battery to the dynamo-electric machine, which is always present at the beginning of the starting operation, would continue while the handle 39 was being held in positions B and C. Now, the armature 26 is so designed that while such a heavy current is passing through the coil 45, the magnetism induced is sufficient to oversaturate the armature. Hence, the lines of force seek another path, which they find in armature 25, which is of considerably greater permeability than armature 26. As soon as the operator releases the handle 39 and it moves to neutral position, armature 25 is free to move downwardly, which it does in response to the heavy magnetic flux. There being nothing in the way, the armature 25 moves into direct contact with the pole piece, forming a nearly closed path for the lines of force of the magnet. The lines which theretofore threaded the armature 26 were forced to pass through a gap caused by the non-magnetic projections 9, and hence, they at once take the easier path through the armature 25 after that armature comes into

engagement with the pole piece. Thus the armature 25 magnetically short circuits the armature 26, and the latter armature tilts upwardly at its forward end in response to the action of the weight 28, thereby breaking the contacts 30, 32 and 31, 33 and preventing further discharge of the battery through the dynamo-electric machine. By this means also, the operator is apprised of the fact that the engine is not in working order.

However, the above conditions will seldom obtain. If the engine has a supply of fuel, and if the carbureting and igniting apparatuses are in proper order, the engine will start. During starting, current flows from the battery 18 through wire 44, coil 45, contacts 30 and 32, and wire 47, to the machine 10, then acting as a motor, and from the machine 10 through wire 48, ampere-hour meter 20 and wire 51 back to the battery. Current for the field 52 flows from the battery 18 through wire 44, coil 45, wire 46, contacts 31 and 33 and wire 53 to the field coils 52, thence through wire 54 to the machine 10 and from the latter through wire 48, ampere-hour meter 20 and wire 51 back to the battery. A fraction of the current passing through contacts 30 and 32, passes through the shunt consisting of wire 57, and coils 58 and 60 to ground at 61, and from ground at 80 or 81 through wire 48, ampere-hour meter 20 and wire 51 back to the battery.

During the discharge of the battery the magnetic effects of the coils 45 and 58 are cumulative, and are opposed by the magnetic effect of the coil 60. The latter coil is considerably stronger than coil 58, but during starting, the current passing through coil 45 is very heavy and is easily sufficient to produce a magnetic effect overbalancing the algebraic sum of the effects of the coils 58 and 60, and hence, holds the armature 26 in attracted position. While the motor is getting up speed, its load gradually decreases, and the effort required merely to keep the engine shaft turning at a given speed is so much less than that required to start the rotation, that the current passing through the coil 45 after the motor is up to speed no longer produces enough magnetism to overcome the algebraic sum of the effects of coils 58 and 60, together with the effect of the weight 28. Hence upon release of handle 39, if the engine has not by that time begun to fire and to run under its own power, the armature 26 rocks back on its pivot, breaking the electrical connections and terminating the discharge of current from the battery through the motor.

In case the engine starts properly, as it will do in the great majority of instances before the operator releases the handle 39, the electric machine 10 will then become a generator and will send current back through the main circuit, that is, from the machine 10 through the wire 47, contacts 32 and 30, wire 46, coil 45, wire 44 to the battery 18 and thence through wire 51, ampere-hour meter 20 and wire 48 back to the electric machine 10. Current for the field will flow through wire 47, contacts 32, 30, 31 and 33 and wire 53 to the field coils 52, and thence through wire 54 to the electric machine 10. Current for the shunt coils 58 and 60 flows in the same direction as before, going from the electric machine 10 to wire 47, contact 32, wire 57, coils 58 and 60 to the ground at 61, and from the ground at 80 back to the machine 10. Ignition current flows from the third brush 67 of the dynamo-electric machine through wire 68, winding 59, timer 70 to ground and from ground at 80 back to the dynamo-electric machine. Part of the current generated may be used for the load 19 directly, and without traversing the ampere-hour meter 20, its course being from the dynamo-electric machine 10 through wire 47, contacts 32 and 30, wire 46, coil 45, wires 44 and 56, to the load 19 and thence through wires 55 and 48 back to the dynamo-electric machine.

At this time, during charging of the battery, the current through coil 45 is in a direction opposite that which it takes during the discharging of the battery. Consequently the magnetic effect of the coil 45 is like that of coil 60 instead of like that of coil 58, which is now opposed to that of coils 45 and 60. These latter coils are much stronger than coil 58 and hence, easily hold in the armature 26. When, however, battery 18 is fully charged, and the hand 65 moves around until the contact points 64 and 63 touch, a short circuit is formed around coil 60 by way of wire 62, contact points 63 and 64, meter hand 65, wire 66, meter terminal 49 and wire 48 back to the dynamo. When this occurs the coil 45 not only loses the assistance of coil 60, but a slightly heavier current traverses the opposing coil 58, because of the lesser resistance. The magnetic effect of the coil 45 is then not sufficient to counteract both the effect of the coil 58 and the effect of the weight 28. Consequently the armature 26 tips back on its pivot 24 and the electric circuit joining the battery and dynamo is broken. At the same time the field circuit of the dynamo-electric machine is broken, and hence the latter ceases to generate current for the engine ignition, and the engine necessarily stops.

Should the operator desire to stop the engine before the battery is completely charged, he may do so at any time by merely depressing button 42 until armature 25 contacts with pole piece 22, whereupon armature 26 is magnetically short circuited and

the electrical contacts 30, 32 and 31, 33 broken.

Attention is called to the fact that when the engine is being started and the operator throws the handle 39 to the position B for that purpose, the contacts 30 and 31 are depressed until the contact 31 touches the contact 33, when a current impulse passes through the field 52, thus preventing too great a surge of current through the armature of the motor, when the contacts 30 and 32 come into engagement. Also, this first current impulse in passing through the field 52, threads the magnet coil 45 and induces magnetism, which acts upon the armature 26 pulling it quickly down upon the magnetic insulation 9 and completing the tight engagement of the contacts 30, 32 and 31, 33. This is an important feature of the invention, in that it reduces heating of the contacts when connection is made.

I am aware that the particular embodiment of my invention above described, and illustrated in the accompanying drawing, is susceptible of considerable variation without departing from the spirit thereof, and therefore I desire to claim my invention broadly as well as specifically, as indicated by the appended claims.

I claim as my invention:

1. In an electric generating system, an electric circuit, an automatic switch for opening and closing said circuit, a gas engine having cranking means operable by said electric circuit and having a compression relief valve, a switch operating handle capable of limited motion in either direction, means for manually closing the switch by moving the handle to either extreme position, means for opening said compression relief valve operable by movement of the handle to one extreme position only, and means for automatically returning the handle to intermediate or neutral position whenever it is released by the operator.

2. In an electric generating system, an electric circuit, an automatic switch for opening and closing said circuit, a gas engine having a compression relief valve and cranking means operable by said switch, a switch operating handle capable of limited motion in either direction, means for manually closing the switch by moving the handle to either extreme position, means for opening said compression relief valve operable by movement of the handle to one extreme position only, means for automatically returning the handle to intermediate or neutral position whenever it is released by the operator, and electro-magnetic means for holding said switch closed.

3. In combination, a gas engine having electric cranking means and a compression relief valve, a current source for said cranking means, an electro-magnet having a coil and a pole piece, a pair of armatures in position to be attracted by said pole piece, one of said armatures carrying an electric contact, a fixed contact adapted to be engaged by said armature when said armature is shifted toward the pole piece, an electric circuit including said current source and electro-magnet coil, non-magnetic material interposed between said contact carrying armature and said pole piece, a rock shaft capable of limited motion in either direction from a neutral position, a handle therefor, a valve operating rod, means operated by said shaft when thrown to one extreme position to accomplish three purposes, first, to shift said rod longitudinally to open said valve, second, to shift said contact carrying armature towards said pole piece, and third, to hold the other armature away from said pole piece, and when thrown to the other extreme position, to withdraw said rod, but to keep the armatures in the positions aforesaid, and means tending to withdraw said contact carrying armature, whereby, when said handle is returned to neutral position, a current of more than a certain predetermined strength will oversaturate said contact carrying armature, and cause said other armature to be drawn into engagement with said pole piece, thereby magnetically short circuiting said contact carrying armature and permitting it to be withdrawn.

4. In an electric generating system, a gas engine and a motor operatively connected together, a storage battery, a series circuit in which said motor and battery are connected, an electro-magnet having one coil connected in said series circuit and a second coil connected in a shunt across said series circuit, a pole piece for said magnet, a pair of armatures adapted to be attracted by said pole piece, an electric contact carried by one of said armatures, a fixed contact in position to be engaged thereby, said contacts being contained in said series circuit, means tending to retract said armature, the magnetic effects of said series and shunt coils being opposed during the discharging of said battery, the coils being so designed that during the heavy discharging at the beginning of the engine starting operation, the magnetic effect of the series coil overbalances that of the shunt coil and maintains said contacts together, while as the motor approaches its normal speed, this overbalancing effect is lessened and finally overcome by the tendency of the switch to open, whereby the series circuit is broken in case the engine fails to start, means for preventing said contact carrying armature from coming into direct engagement with said pole piece, whereby when said electro-magnet is energized sufficiently, before the engine shaft begins to turn, said contact carrying armature will be oversaturated and the other armature drawn

into engagement with the pole piece, thus magnetically short circuiting the contact armature and permitting it to be withdrawn.

5. In combination, a gas engine and an electric motor operatively connected, a current source, an electro-magnet, an armature therefor, a switch controlled by said armature, said current source, electro-magnet, switch and motor being in circuit when said armature is attracted, means for manually shifting said armature into attracted position, said magnet being so designed as to hold said armature in attracted position while the heavy current necessary to bring the motor up to speed is passing, but to release said armature because of the smaller current passing when said motor attains a predetermined higher speed and means for magnetically short circuiting said armature and opening the switch after said manual means is withdrawn in case the engine fails to turn.

In testimony whereof, I affix my signature.

CARL P. BROCKWAY.