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T. W. DRURY

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CONTROL SYSTEM FOR FARM LIGHTING PLANTS

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Fig. 1.

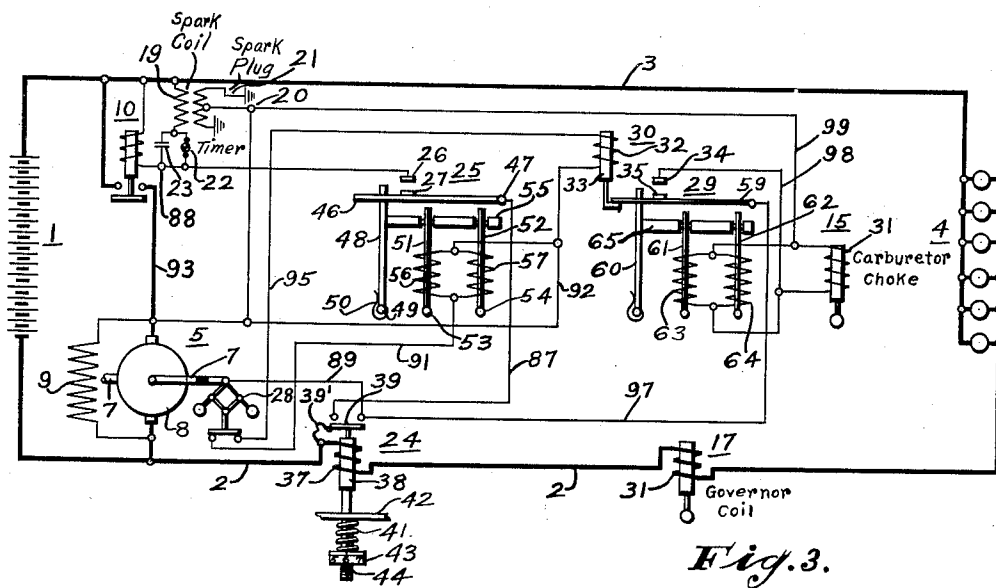
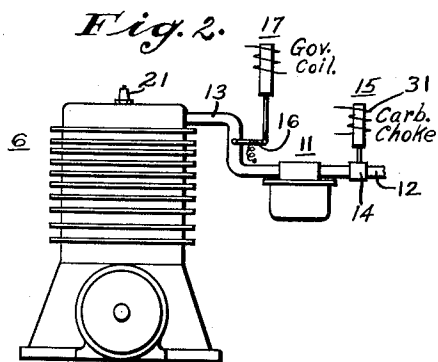
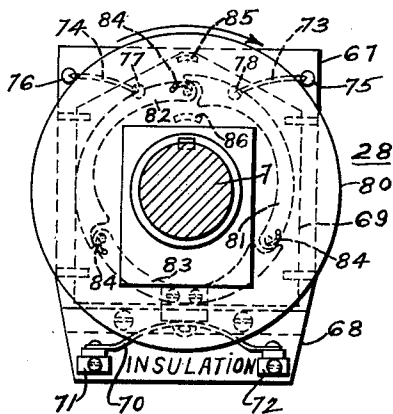


Fig. 3.



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## UNITED STATES PATENT OFFICE

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## CONTROL SYSTEM FOR FARM LIGHTING PLANTS

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This invention relates generally to control systems for electric power plants such as are suitable for farm lighting and similar services.

5 An object of the invention is to provide a power unit, that shall be simple in construction, automatic and efficient in its operation and easily manufactured and installed.

10 Another object of the invention is to provide for automatically controlling the choker valve of a carburetor for an internal combustion engine to obtain quick starting and economical running of the engine.

15 And a further object of the invention is to provide for controlling the choker valve of an internal combustion engine both in response to the speed of the engine and in accordance with predetermined temperature conditions.

20 Other objects of the invention will be obvious when the following specification is considered in conjunction with the accompanying drawings, in which:

25 Figure 1 is a schematic illustration of circuits and apparatus arranged in accordance with the invention;

30 Fig. 2 is a schematic illustration of an internal combustion engine showing how control apparatus shown in Fig. 1 may be applied to the carburetor to regulate the fuel supply, and

Fig. 3 is a view, of a speed responsive switch employed in conjunction with the circuits and apparatus shown in Fig. 1.

35 In the system shown in the drawings, a battery 1 may be provided for supplying electric current at any suitable voltage to a work circuit including supply conductors 2 and 3 and electric power consuming devices 4, as, for example, incandescent lamps. To provide for the charging of the battery 1 and the supplying of additional current to the work circuit when certain conditions, to be hereinafter set forth, prevail in the work circuit, a dynamo electric machine 5 and an internal combustion engine 6 are provided.

40 The engine 6 may be mechanically coupled to the shaft 7 of the machine 5 in any suitable or well known manner. As shown, the ma-

chine 5 is of the shunt type and comprises an armature 8 and a shunt field winding 9.

In order that the machine 5 may be connected across the terminals of the battery 1, or disconnected therefrom, an electromagnetic switch 10 biased to open position is provided.

The engine 6 is provided with a carburetor 11 having an air inlet conduit 12 and a conduit or manifold 13 for conveying the fuel mixture to the explosion chamber of the engine.

With a view to providing a rich fuel mixture to facilitate starting of the engine 6 when it is cranked, a choker valve 14 is disposed in the air inlet conduit 12 and an electro-responsive or solenoid device 15 is provided for actuating the valve in a manner that will be set forth hereinafter. The carburetor is provided with a throttle 16 and a throttle-actuating device 17 of the solenoid type, the operation of which device is responsive to the value of current flowing in the work circuit, which in this case is the supply conductor 2.

75 The engine 6 is provided with an ignition circuit which includes a primary coil 19, a secondary coil 20, a spark plug 21 connected to the coil 20, a timer or circuit interrupter 22 and a condenser 23 connected across the terminals of the interrupter or timer.

80 Since the machine 5 is of the shunt type, the armature will turn in the same direction whether it is operating as a motor or a generator. If the switch 10 is closed to connect the respective armature and field windings 8 and 9 across the battery 1, the machine will operate as a motor to crank the internal-combustion engine 6. Assuming that the explosive mixture developed by the carburetor 11 is of the proper kind, the engine 6 will, when cranked, start and operate the machine 5 as a generator.

85 In systems of the type shown in the drawing, it is desirable to provide for the closing of the switch 10 to initiate the cranking of the engine 6 by the dynamo 5, when the current flowing in the work circuit exceeds a predetermined value, for example, six amperes. This may be accomplished by the provision of a series relay 24, the actuating coil of which is connected in to carry the current that may flow in the work circuit. Therefore, the

operation of the relay is dependent upon the value of current flowing in the supply conductor 2 of the work circuit. To provide for the opening of the switch 10 in the event that the engine 6 fails to start after it has been cranked for a predetermined length of time, a cranking time-delay thermal relay 25 is provided for interrupting the energizing circuit of the actuating coil of the switch 10 and the ignition circuit. It is to be noted that the primary coil 19, the timing device 22 and the condenser 23 are connected in parallel-circuit relation to the operating coil of the switch 10. If the relay 25 has operated to interrupt the energizing circuit of both the operating coil of the switch 10 and the ignition circuit, it will remain in its operated position until the switch contacts 26 and 27 thereof have been reclosed by the operator or attendant. Further detailed description of the relay and its mode of operation will be given hereinafter.

To prevent operation of the relay 25 after the engine has started and has attained a speed of a predetermined value, a speed responsive switch 28 is provided for interrupting a heating circuit for thermal elements of the relay 25, which circuit and elements will be described hereinafter. For the present purpose, the switch 28 may be mounted on the commutator end of the armature shaft 7.

In order to cause the choker valve 14 to operate the moment the engine 6 is cranked by the dynamo 5, a time-delay thermal relay 29 and an electro-responsive device 30 are provided for jointly governing the energization of the actuating coil 31 of the choker valve actuating device 15.

The electro-responsive device 30 comprises a coil 32 and armature 33 disposed for operation thereby to close switch contact members 34 and 35 of the relay 29 when the line series relay 24 and the switch 10 have been closed. The operation of the device 30 prevents the separation of the contact members 34 and 35 so long as the coil 32 is energized, but will permit the contact members to be opened by the thermal elements of the relay 29 when the speed responsive switch 28 has been operated to effect the deenergization of the coil 32. Further detailed description of the relay 29 and its mode of operation will be given hereinafter.

The series relay 24 comprises an actuating coil 37, an armature 38, and a contact bridging member 39 disposed for operation by the armature. The armature 38 may be biased towards a position in which the contact members of the relay 24 are open, by means of a spring 41 positioned between a fixed support 42 and an adjustable or calibrating support 43. The biasing force may be regulated by the calibrating support 43 that makes threaded engagement with an extension 44 of the armature 38. The position of the movable support 43 will determine the value of

current flowing through the coil 37 of the relay 24 at which the contact members of the relay will be closed. The position of the support 43, hence the degree of compression initially applied to the spring when the relay is in the open position, will determine both the "pull in" and "drop out" values of current flowing in the coil 37 at which the relay will either close or open the contact members thereof.

For example, if the movable support 43 is adjusted to a certain position, for instance, the position shown in Fig. 1 of the drawings, a current flow of six amperes through the coil 37 may be required to close the contact members of the relay 24. The relay having been closed, a smaller value of current than six amperes will maintain it closed; therefore, if the current is reduced to a value below six amperes, a balancing point will be reached at which the magnetic pull of the coil on the armature will balance the pull of the spring 41 on the armature. If the current is reduced still further, the spring 41 will overcome the magnetic pull of the coil and the relay will be actuated to its open-circuit position. The value of current traversing the coil 37 at which the relay will "drop out" or open may be as low as three amperes when the closing value of current is six amperes.

The relay 25 comprises a support 46 pivoted at 47 on which the contact member 27 is mounted, a latch 48 pivoted at 49 and biased towards the right by a spring 50 as shown in Fig. 1, and two strips of bimetal 51 and 52, the lower ends of which may be stationarily mounted as at 53 and 54. Movement of the free ends of the bimetal strips 51 and 52 may be transmitted to the latch 48 through a push-rod 55.

When the contact members 26 and 27 of the relay 25 are closed, the coil of the switch 10 and the ignition circuit for the engine 6 may be established when the relay 24 is closed. In order to cause the contacts 26 and 27 to be opened, if the engine fails to start after it has been cranked for a predetermined length of time, the bimetal strips 51 and 52 are provided with electric heating elements or resistors 56 and 57.

The resistors 56 and 57 may be connected in parallel-circuit relation across the armature of the machine 5 when the contacts of the relay 24 are closed. When the strips 51 and 52 have been heated to a temperature of a predetermined value, their free ends will deflect towards the left, thereby actuating the latch 48 to a position at which the pivoted support 46 will be released to the position shown in Fig. 1 of the drawings. In this position, the contacts 26 and 27 are opened whereby the coil of the switch 10 and the ignition circuit for the engine 6 are deenergized.

Further cranking of engine 6 is precluded

until the contacts 26 and 27 have been manually reclosed and latched in their circuit-closing positions. Therefore, if the engine 6 is out of order and the relay 25 has operated as stated above, the attendant of the system will be warned that the engine has failed to start responsive to the cranking thereof and he may then investigate the source of trouble before he recloses the contacts 26 and 27 of the relay 25. Since the free ends of the strips 51 and 52 may, upon changes in temperature move in either direction, i. e. to the right or left, it follows that the engine may be cranked for a longer period of time in cold weather than in hot weather.

The relay 29 is substantially identical in construction to the relay 25 and comprises a support 59 pivoted at one end, a latch 60 therefor, strips of bi-metal 61 and 62 provided with heating elements or resistors 63 and 64 connected in parallel-circuit relation to each other and a push-rod 65 for actuating the latch 60 in response to movement or deflection of the free ends of the bimetal strips 61 and 62. It is to be noted that the device 30 is utilized for actuating the support 59 to close the switch contacts 34 and 35.

When the coil 32 of the electro-responsive device 30 is energized, the armature 33 is moved upwardly thereby actuating the support 59 to a position in which it will be latched by the latch 60. In this position the contacts 34 and 35 are closed.

When the contact members of the relays 25 and 29, and the centrifugal switch 28 are closed, circuits for the resistor heating elements 56 and 57, 63 and 64 and the actuating coil 31 of the carburetor choker valve actuating device will be established. It is to be noted that the resistor elements 63 and 64, and the coil 31 are connected in parallel-circuit relation to each other across the armature 8 of the machine 5.

The construction of the speed responsive or centrifugal switch 28 as embodied in system herein disclosed, is shown more particularly in Fig. 3 of the drawings. This switch comprises a supporting plate 67 provided with an opening to receive the shaft 7 of the generator, a contact supporting member 68 of insulating material secured to the bottom of the supporting plate 67 and a movable contact supporting member 69 disposed for vertical movement with respect to the stationary plate 67. A resilient contact-bridging member 70 is mounted on the movable member 69 and is disposed to engage stationary contact members 71 and 72 carried by the contact supporting member 68. The contact members are bridged when the member 68 is in the position shown in Fig. 3 of the drawings.

In order to effect quick make-and-break of the bridging member 70 with respect to the stationary contact members 71 and 72,

leaf springs 73 and 74 are provided. One end of each of these springs engages stationary lugs 75 and 76 mounted on the plate 67 and the other ends thereof engage lugs 77 and 78 mounted on the movable contact supporting member 69. As will be noted, the leaf springs 73 and 74 are normally held in compression between the lugs as is evident from the fact that they appear to be bowed or deflected, as shown in Fig. 3. The leaf springs 73 and 74, the movable support 69 and the stationary supports 67 operate as a toggle mechanism to effect quick make-and-break of the contact bridging member 70 with respect to the stationary contact members 71 and 72.

In order to provide for the operation of the switch in accordance with the speed of rotation of the armature 8 of the machine 5, a circular plate 80 is keyed to the shaft 7 in any suitable manner and provided with a plurality of weights 81 to 83, inclusive. Each of the weights are pivotally mounted at one end on the plate 80 and biased by springs 84 so as to oppose the centrifugal force imparted thereto when the shaft 7 is turning. As will be observed, the weights 81 to 83, inclusive, are so positioned that they will pass between lugs 85 and 86 mounted on the movable contact supporting plate 69.

If the shaft 7 is turning faster than a certain number of revolutions per unit of time, the free ends of the weights 81 to 83, inclusive, will swing outwardly against the lug 85 to actuate the toggle mechanism and thereby cause separation of the contact bridging member 70 from the stationary contacts 71 and 72 with a snap action. If the number of revolutions per unit of time at which the shaft 7 is turning falls below a predetermined value, the free ends of the weight members will move towards the position shown in Fig. 3 of the drawings and cause the toggle mechanism to operate to effect reclosing of the bridging member 70 upon the stationary contact members 71 and 72.

If the current flowing in the work circuit is below a predetermined value, as for example, below six amperes, the storage battery 1 will supply the current. If the current demand exceeds six amperes, the contact members of the relay 24 will be closed by the coil 37 and a circuit will be established for the ignition coil 19 and the operating coil of the switch 10. The machine 5, driven by the engine 6 will then supply the excess of current above six amperes. These circuits, mentioned above, may be traced from the battery 1 through the supply conductor 2, the contact bridging member 39 of the relay 24, conductor 87, contact members 26 and 27 of the relay 25, junction point 88, the operating coil of switch 10 to the supply conductor 3 and the battery 1. The circuit for the coil 19 of the ignition apparatus may be traced from

the junction point 88 through the condenser 23, the coil 19 to the supply conductor 3.

The coil of the switch 10 having been energized, the switch will be closed and the dynamo 5 connected across the battery for operation as a motor to crank the engine 6.

Upon the closing of the relay 24, a circuit for the resistor elements 56 and 57 and the coil 32 of the electro-responsive device 30 are established. These circuits may be traced from the battery 1 through supply conductor 2, jumper 39', contact bridging member 39 of the relay 24, conductor 89, the contact members of the centrifugal switch 28, conductor 91, the resistor elements 56 and 57, and conductor 92 to the armature 8 of the dynamo 5.

The circuit for the coil 32 of the electro-responsive device 30 may be traced from the battery 1 through the supply conductor 2, jumper 39', contact bridging member 39 of the relay 24, conductor 89, the contact members of the centrifugal switch 28, conductor 95, the coil 32 of the electro-responsive device 30, and conductor 92 to the armature 8 of the dynamo 5. The coil 32 having been energized, the pivotally mounted member 59 will be actuated to the position in which it is latched by the latch 60 and the contact members 34 and 35 of the relay 29 closed.

When the contact members 34 and 35 are closed, circuits for the resistor elements 63 and 64 provided for the bimetal strips 61 and 62, respectively, and the coil 31 of the choker-valve actuating device 15 are established. These circuits may be traced from the battery 1 through supply conductor 2, the contact bridging member 39 of the relay 24, conductor 97, contact members 34 and 35 of the relay 29, conductor 98, then the resistor elements 63 and 64 and the coil 31 connected in parallel, circuit relation and back to the battery 1 through conductors 99 and 93 and the switch 10. When the coil 31 is energized, the choker valve 14 is closed to restrict the flow of air into the carburetor 11.

When the switch 10 has been closed as previously stated herein, the machine 5 will operate as a motor to crank the engine 6. If starting conditions of the engine 6 are proper, it will respond to the cranking and operate like any other internal combustion engine and will drive the dynamo 5 as a generator. When the speed of the generator exceeds a predetermined value, the centrifugal switch 28 will operate to disengage the bridging member 70 from the stationary contact members 71 and 72. Deenergization of the resistor elements 56 and 57 of the relay 25 and the coil 32 of the switch contact closing device 30 of the relay 29 is thereby effected. The contacts 26 and 27 of the relay 25 will therefore remain closed to permit continued operation of the engine 6 and the dynamo 5 as a generator to supply charging current to

the battery 1 as well as current to the work circuit.

The coil 32 having been deenergized, the bimetal strips 61 and 62 are free to actuate the latch 60 and thereby cause disengagement of the contact members 34 and 35 after the carburetor choker valve has been held closed for a predetermined length of time. It is to be observed in this connection that so long as the coil 32 of the device 30 is energized, the contact members 34 and 35 will be closed even though the latch has been actuated to the position in which the pivotally mounted member 59 will fall by the action of gravity to the position shown in Fig. 1 of the drawings. It is to be noted that since the bimetal strips 61 and 62 are responsive to ambient temperatures, the choker valve will be closed longer in cold weather than hot weather which is a condition to be desired.

In order that the output of the motor 6 may be regulated in accordance with the power demand required thereof, the coil of the throttle-actuating device 17 is connected in series with the supply conductor 2. The greater the current flowing in the supply conductor 2, the greater will be the pull of the coil upon the armature of the throttle-actuating device 17. Therefore, the throttle valve will be opened or closed in accordance with the power demand on the engine to admit more or less of the fuel mixture into the explosion chamber of the engine.

If the current in the work circuit falls below six amperes, but not to a value sufficient to cause the relay 24 to open its contact members, the engine 6 will continue to operate to drive the machine 5 as a generator but if the current falls to a certain value at which the spring 41 will overcome the pull of the coil 37 on the armature 38, the relay will drop out and effect an opening of the switch 10. When the contact members of the relay 24 are opened, the ignition circuit and the circuit for the actuating coil of the switch 10 will be deenergized. Consequently, the motor is stopped and the dynamo 5 disconnected from the battery.

From the foregoing description, it is apparent that since the battery is utilized merely for supplying small quantities of power to the work circuit, the battery may be of light construction and of small capacity because the generator operates to supply the excess load demand of the work circuit and also to recharge the battery each time the motor 6 and the machine 5 are started as a motor-generator unit. The system includes a minimum of relays and switches, the device will operate satisfactorily with very little attention and is completely automatic in its operation.

Since changes may be made in the circuits and apparatus of the present embodiment without departing from the spirit and scope

of the invention, it is, therefore, desired that only such limitations shall be placed thereon as are imposed by the prior art and the appended claims.

5 I claim as my invention:

1. In a power system in combination, an internal combustion engine provided with a choker valve, a generator disposed to be driven by the engine, a battery disposed to be connected across the generator to operate it as a motor to crank the engine, a centrifugal switch responsive to the speed of the generator, a coil connected across the generator for actuating the choker valve, a thermostatically operated switch for controlling the energization of the choker valve actuating coil, and an electromagnetically operated latch for controlling the operation of the thermostatically operated switch, said latch being dependent for its operation upon the centrifugal switch.

2. In a power system in combination, an internal combustion engine provided with a choker valve, a generator disposed to be driven by the engine, a battery disposed to be connected across the generator to operate it as a motor to crank the engine, a centrifugal switch responsive to the speed of the generator, electro-responsive means for actuating the choker valve, a circuit for energizing said electro-responsive means, electromagnetically operated means for controlling said energizing circuit a thermostat for controlling said energizing circuit, said electromagnetically operated means and thermostat being interdependent whereby the interruption of the energizing circuit will depend on both.

3. In a power system in combination, an internal combustion engine provided with a choker valve, a generator disposed to be driven by the engine, a battery disposed to be connected across the generator to operate it as a motor to crank the engine, a centrifugal switch responsive to the speed of the generator, electromagnetic means for actuating the choker valve, a circuit for energizing the electromagnetic means, means dependent upon the speed of generator for interrupting the circuit, means dependent upon temperature for interrupting the circuit, said circuit interrupting means, being dependent upon the generator speed, and said temperature responsive means being interdependent on both temperature and speed to prevent the interruption of the circuit before both the speed and temperature conditions are fulfilled.

4. In a system for controlling the choking operation of an internal combustion engine provided with a carburetor and a choker valve therefor, in combination, a coil for operating said valve, a switch for controlling said coil, means for closing said switch when a cranking operation for the engine is performed, means responsive to the speed of the engine for deenergizing said switch closing

means at a predetermined engine speed, and thermal responsive means for opening said switch after the engine has been operating for a predetermined length of time, whereby said choke-valve actuating coil is deenergized.

5. In a system for controlling the choking operation of an internal combustion engine provided with a carburetor having a choker valve, in combination, a coil for operating said valve, a switch for establishing an energizing circuit for said valve operating coil, a coil for closing said switch responsive to the cranking of the engine, said switch closing coil being disposed to oppose the opening of said switch if the engine speed is below a predetermined valve, means responsive to a predetermined speed of the engine for deenergizing said switch closing coil, and temperature responsive means rendered active upon the closing of said switch for opening said switch to interrupt the choking of said carburetor after a predetermined length of time, said choking of the carburetor being interrupted only when the engine speed-responsive device has operated.

6. In a system for controlling the choking operation of an internal combustion engine provided with a carburetor having a choker valve therefor, in combination, means for cranking said engine, means responsive to the cranking of said engine for actuating said choker valve, temperature responsive means for controlling said valve actuating means, and means responsive to the speed of said engine for precluding the operation of said temperature responsive means until the speed of said engine has reached a predetermined value.

In testimony whereof, I have hereunto subscribed my name this first day of December, 1928.

THOMAS W. DRURY.