

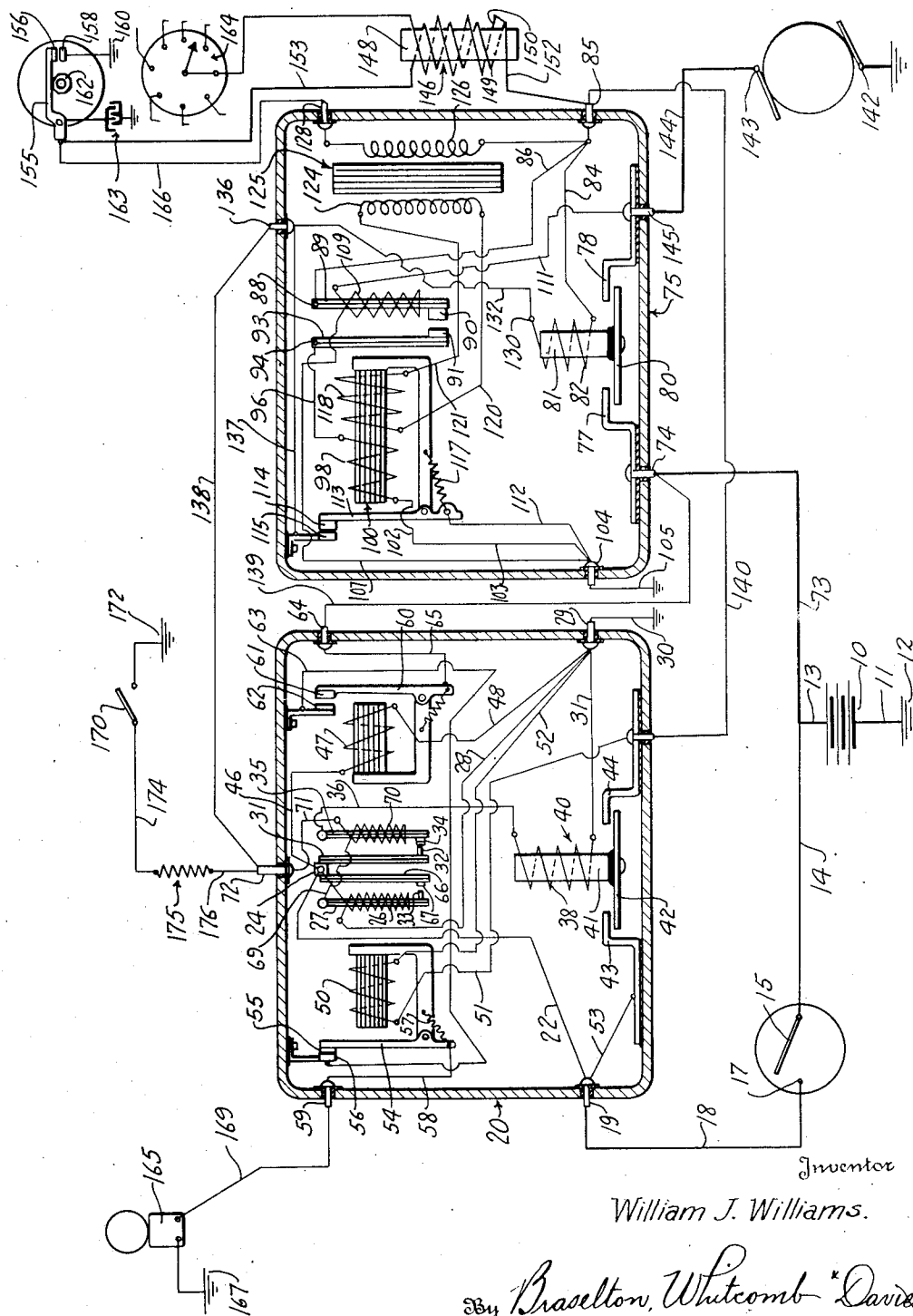
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CENTRAL SYSTEM FOR ENGINE STARTING MEANS

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CONTROL SYSTEM FOR ENGINE STARTING MEANS

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This invention relates to a system for controlling the starting and ignition means used in connection with an internal combustion engine as is particularly directed to means for controlling the duration of application of power to operate said means.

The invention embraces means operable to interrupt the application of power to the starting and ignition system of an engine after a certain period of time.

This invention also comprehends means to render ineffective the operation of the starting means for an engine when the latter fails to start under its own power and to re-establish said operation after a certain predetermined period of time.

One of the objects of the present invention resides in the utilization of time responsive means for controlling the starting motor operation causing the periodic actuation of the starting motor for a predetermined period of time.

Another object of the invention is the provision of means for automatically starting an engine and when the same fails to start render the starting means ineffective and concurrently cause the initiation of the starting means associated with another engine without requiring the presence of a human agency.

Another object of the invention resides in the use of the production of a current controlled by the self-actuation of the engine for rendering the starting motor circuit ineffective.

A further object of the invention is the provision of means to place out of operating condition an engine which fails to start or is operating under abnormal conditions giving a warning signal, or if desired to initiate automatically the starting operation of a stand-by engine.

A still further object of the invention is the provision of means to render ineffective the control means operable to cause the periodic application of power to the starting means after a predetermined number of power applications and concurrently producing a warning signal.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

The figure is a diagrammatic view illustrating

the preferred form of the system of control for a starting and ignition means used with internal combustion engines.

The principles of the invention are herein illustrated as embodied in a control system for a storage battery starting and ignition means for an internal combustion engine, and it is to be understood that I contemplate the utilization of the invention to control other types of engine starting means including its use to control pneumatic or fluid pressure operated starting means.

Referring to the embodiment illustrated diagrammatically in Figure 1, the control system of the invention includes a suitable source of energy such as a storage battery 10 having one terminal connected by means of lead 11 to a ground or common return means 12 which in the present instance may be the engine frame. The other terminal 13 of the battery 10 is connected by means of lead 14 to the movable blade 15 or to the circuit closing means of a switch which may be the switch which normally controls the engine ignition system. The switch blade 15 is adapted to engage contact 17 which in turn is connected by lead 18 to a circuit terminal or connecting post 19 insulatingly carried by and projecting through one of the side walls of the casing 20. The casing 20 encloses and supports certain of the electro-responsive devices which control the starting and ignition circuits constituting one of the units of the control system of the invention.

The connecting post 19 is connected by means of lead 22 to a bus bar on current distributing post 24 insulatingly supported by the casing 20. To the distributing post 24 is connected one end of the heating coil 26 which surrounds the thermo-responsive or bimetallic contact carrying element 27 located in heat receiving relation to coil 26. The other terminal of the heating coil 26 is connected by means of lead 28 to a circuit terminal 29 insulatingly carried and projecting through one of the side walls of casing 20. The circuit terminal 29 is adapted to be connected by means of lead 30 to a suitable ground providing a return path to the grounded terminal of battery 10.

The current distributing post 24 is connected to the stationary or pivoted end of the bimetallic or thermo-responsive element 31 which carries at its free end a contact 32 normally in engagement with a contact 34 carried by a thermo-responsive or bimetallic member 35. The pivoted end of the bimetallic member 35 is connected by means of lead 36 to one end of the energizing winding 38 which in turn has its end connected by means of

a lead 31 to connecting post 29. The windings 38 constitute the control means for the electro-magnetic switch 40 and are adapted to move a magnetic core 41 insulatingly carrying the contacting bar 42. The contact bar 42 is adapted to engage the spaced contacts 43 and 44 insulatingly carried on the bottom wall of casing 20.

The bus bar 24 is also connected by means of lead 46 to one end of the relay energizing windings 47, the other end being connected by lead 48 to the insulated connecting post 29. The casing 20 also supports a second relay having suitable energizing windings 50 having one end connected by means of lead 51 to the stationary contact 44 of the electro-magnetic switch 40 while the other terminal of the relay winding 50 is connected by lead 52 to the circuit terminal 29. The stationary contact 43 of the electro-magnetic switch 40 is connected by means of a lead 53 to connecting post or terminal 19.

The relay windings 50 are used to attract armature 54 carrying a contact 55 normally urged into engagement with a stationary contact 56 by means of a spring 57 which serves to hold the armature away from the relay core. The armature contact 55 is connected by a lead 58 to terminal or post 59 insulatingly carried and projecting through the one side of walls of the casing 20. The relay windings 47 are adapted when energized to attract armature 60 carrying a contact 61 into engagement with a stationary contact 62 insulatingly supported within the casing 20 which is connected by means of lead 63 to the insulated contact 56 also carried by the housing walls. The armature contact 61 is connected by lead 65 to an insulated terminal or post 64 carried by and projecting through one of the side walls of the casing 20. The contact 61 is normally held out of engaging relation with contact 62 by a suitable spring connected to the relay armature 60.

Suitably spaced from the thermostatic element 27 is a bimetallic element 66 carrying a contact 67 adapted to be engaged by contact 33 carried by the bimetallic element 27. The bimetallic element 66 is directly connected to the distributing bar 24 while the stationary or pivoted end of bimetallic element 27 is connected by means of lead 69 to one end of a heating coil 70 surrounding the bimetallic element 35, while the other end of coil 70 is connected by lead 71 to an insulated post 72 projecting through the upper wall of the casing 20.

The terminal 13 of battery 10 is also connected by lead 73 to a terminal post 74 projecting through the side wall and insulatingly carried by one of the side walls of the casing 75. The casing 75 serves to enclose and support certain electro-responsive devices forming a second unit for controlling the operation of the engine starting and ignition means. The post 74 is in engagement with a contact member 77 insulatingly supported upon the inner surface of the casing 75 and suitably spaced from an insulated contact member 78. Contacts 77 and 78 are adapted to be bridged by a conducting bar 80 insulatingly carried by the magnetic core 81, which is surrounded by the energizing winding 82, thereby forming an electro-magnetic switching element. One terminal of the electro-magnetic switch winding 82 is connected by lead 84 to an insulatingly supported terminal post 85 carried by one of the side walls of the casing 75.

The terminal 85 is connected by means of a lead 86 to the stationary or pivotal point 88 of

a thermo-responsive element 89, carrying at its other free end a contact 90. The contact 90 is adapted to engage a contact 91 carried by the movable end of the bi-metallic member 93, the latter being pivoted as at 94 and connected by means of lead 96 to one of the terminals of the winding 98 of the relay 100. The other terminal of the winding 98 is connected by leads 102 and 103 to the terminal post 104, the latter projecting through one of the side walls of the housing 75 and being connected by leads 105 to a suitable ground.

The terminal post 104 is connected by means of lead 107 to one terminal of the heating coil 109 which surrounds the thermo-responsive element 89, the other terminal of the heating coil 109 being connected by means of lead 111 to the electro-magnetic switch contact 78. The terminal post 104 is connected by means of lead 112 to a relay armature 113 carrying the contact 114 normally urged into engagement with an insulated stationary contact 115 by means of the relay spring 117.

The relay 100 is also provided with a second winding 118 connected by leads 120 and 121 to the secondary winding 124 of a transformer 125, the primary winding 126 of this transformer having one of its terminals connected to the terminal post 128 insulatingly carried by the walls of the housing 75 and having its other terminal connected to the terminal post 85. The terminal 130 of the electro-magnetic switch winding 32 is connected by means of lead 132 to insulated terminal post 136 insulatingly carried by the upper wall of the housing 75. The terminal post 136 is connected by means of lead 137 to the insulated stationary contact 115 and by means of lead 138 to the terminal post 72 of the first control unit. The terminal post 64 of this unit is connected to the terminal post 74 of the second unit by lead 139, while the stationary contact 44 of electro-magnetic switch 40 of the first unit is connected by lead 140 to terminal post 85 of the second control unit.

In the embodiment of the invention illustrated, the engine starting means are electrically actuated but I contemplate to use engine starting means operated by other sources of power. The electrically actuated means shown are in the form of an electric motor having suitable mechanical connections for cranking the engine and capable of being disconnected from the engine when the engine becomes self actuated. The electric starting motor shown has one of its terminals 142 grounded while the terminal 143 is connected by lead 144 to a binding post 145 passing through the wall of the casing 75 and being in direct engagement with stationary contact 78 of the electro-magnetic switch.

The ignition system disclosed which is associated with the engine for producing the proper spark for the combustible mixture includes primarily an ignition coil 146 comprising a core 148 and a primary and secondary winding 149 and 150 respectively. One of the terminals of the primary winding 149 is connected by means of lead 152 to the terminal post 85 while the other terminal is connected by lead 153 to a breaker arm 155 carrying the contact 156 adapted to engage the stationary contact 158 suitably grounded at 160, the breaker arm 155 being actuated by the rotatable camming element 162 driven by the engine in direct proportion to the engine speed and in proper timed relation to produce the interruption of the flow of current through the pri-

mary winding 149 for causing the proper spark for igniting the combustible mixture in each of the cylinders of the engine, constituting the breaker mechanism of the ignition system.

- 5 The condenser 163 is connected across the breaker contacts 156 and 158. One terminal of secondary winding 150 is connected to the central terminal of a current distributor 164. This distributor is operatively connected to the various
10 spark plugs (not shown) carried by each of the engine cylinders. The other terminal of the secondary winding 150 is preferably connected to one terminal of the primary winding 149. The breaker arm 155 is also connected by means of a lead
15 166 to the terminal post 128, whereby the primary winding 126 of the transformer 125 is in parallel with the primary winding 149 of the ignition coil 147 so that the breaker arm 155 also interrupts the current flow in winding 126.
- 20 The system of the invention also includes means to give an indication or alarm whenever the engine is not actuating under its own power, or if desirable to control the starting of a stand-by engine. The indicating means shown include
25 an audible signalling device such as a bell 165 having one terminal grounded at 167 and its other terminal connected by lead 169 to the terminal post 59 which will become energized as will be hereinafter described.
- 30 In addition, the system also includes means to render the engine inoperative by disconnecting the ignition means when abnormal conditions are present in the normal operation, such as improper temperature of the cooling medium used for the
35 engine or improper level of the lubricating medium. These means are diagrammatically illustrated in the form of a movable switching element 170 connected by lead 174 to a suitable resistance 175 and by lead 176 to the connecting post 72.
- 40 The switching element 170 is normally open and is adapted to be connected to a grounded terminal 172 when any of the engine abnormal conditions take place.

The operation of the system hereinbefore described can be summarized as follows:

- 45 When it is desired to start the engine, it will only be necessary to move the switch blade 15 into engagement with contact 17 whereby the electro-responsive means forming the control
50 system are energized establishing an operative connection for the energization of the engine ignition and starting means. The movement of switch blade 15 into engagement with contact 17 will serve to connect the battery to the distributing bus bar 24 through lead 18, terminal post 19
55 and lead 22. The connection of the battery to bus bar 24 will establish a current flow to the energizing winding 38 of the electro-magnetic switch 40. The circuit comprises bus bar 24, bi-metallic element 31, normally engaging contacts
60 32 and 34, hence through the thermo-responsive element 35 by lead 36 to one terminal of the winding 38 and from the other terminal of winding 38 by lead 31 to the binding post 29 grounded by
65 lead 30 thereby completing the energizing circuit of this winding to the battery. The energization of winding 38 will cause the circuit closure 42 to engage contacts 43 and 44 whereby the battery is directly connected through these contacts by
70 means of leads 53 and 140 to the terminal post 85, thus establishing an operative connection to the ignition system by connecting the battery to the primary winding 149 of the ignition coil 146, and at the same time establishing the flow of current
75 to the winding 82 of the electro-magnetic

switch located in the second control unit which controls the energization of the starting motor.

The energizing circuit which establishes the flow of current to winding 82 from binding post 85 includes the lead 84 connected to one terminal
5 of the winding and hence through the winding 82 to terminal 130 connected by means of lead 132 to post 136 connected by lead 137 to stationary contact 115 in engagement with armature
10 contact 114 and by lead 112 to the binding post 104 grounded through lead 105, thus providing a complete path for the flow of current through winding 82.

The flow of current through the winding 82 will attract the core 81 moving bar 80 into engagement with the stationary contacts 77 and 78,
15 thus connecting the battery to the starting motor causing its energization and cranking the engine. The circuit thus established comprises from the terminal 13 of the battery the lead 73, binding post 74, terminals 77 and 78 bridged by contact-
20 ing element 80 and through binding post 145 to terminal 143 of the starting motor through lead 144 and through the motor to terminal 142, the latter being grounded, thus providing a complete
25 path for the flow of current through this circuit.

Concurrently with the energization of the motor and during the period of time that current is flowing from the battery to the starting motor,
30 current is also flowing through the heating coil 109. The energizing circuit for the heating coil 109 comprises from the switch terminal 78 by lead 111 to one terminal of the heating coil 109 and from the other terminal of heating coil 109
35 by lead 107 to the grounded terminal 104, thus producing a shunt branch circuit with the starting motor circuit.

The thermostatic element 89 carrying contact 90 and the heating coil 109 which surrounds this
40 element constitute a circuit closer of a thermal switch. This circuit closer is so calibrated that a current flow during a predetermined period of time will cause its movement towards circuit closing position so that the contact 90 will engage
45 the contact 91. In the form of the embodiment shown, the thermo-responsive element 89 and heating coil are so designed and arranged with respect to the position of contact 91 that the time element required by the action of heating
50 coil 109 to raise the temperature necessary to cause the movement of the thermostatic element 89 to circuit closing position is approximately five seconds. However, this time element can be
55 changed at will. The engagement of contact 90 with contact 91 of the thermal switch will establish a circuit for the energization of relay winding 98 from the battery. This circuit includes
60 battery terminal 13, lead 14, switch blade 15 in engagement with contact 17, lead 18, terminal post 19, lead 53, contact 43 engaged by conducting bar 42 also engaging contact 44, hence by lead 140 to terminal post 85, lead 86, thermostatic
65 element 89, through engaging contacts 90 and 91, thermostatic element 93, lead 96 to a terminal of winding 98 and from the other terminal of winding 98 by leads 102 and 103 to post 104 grounded by lead 105. The energization of winding
70 98 will attract the armature 113 interrupting the engagement of the contact 114 with stationary contact 115, opening the energizing circuit of the electro-magnetic switch winding 82, whereby the bridge contact member 80 will be moved out of engagement with stationary switch contacts 77 and 78, thus interrupting the flow of
75

current to the starting motor, and to the heating coil 109.

If the engine operates under its own power before the time period has lapsed to which the thermo-responsive element 89 is calibrated I have provided means to open the circuit of the electro-magnetic switch winding 82 whereby the starting motor is disconnected from the battery. The type of apparatus and connections employed to produce the disconnection of the starter motor from the battery whenever the engine becomes self-actuated or when the same reaches certain predetermined speed is fully disclosed in detail in my Patent No. 1,917,565, issued July 11, 1933, and function generally as follows: The rotation of the engine will produce a periodic interruption in the flow of battery current flowing through the primary winding 126 of transformer 125 by the action of the breaker arm 155. When the engines becomes self-actuated the rapidity of the interruption caused by the breaker arm 155 is such that an alternating current is induced in the secondary winding 124 of sufficient value to cause the energization of relay winding 118 directly connected therewith to attract the armature 113 overcoming the action of spring 117, thus separating the contacts 114 and 115 and interrupting the flow of current to the electro-magnetic switch winding 82 which in turn causes the interruption in the current flow between the battery and starting motor.

It is important to note that the ratio of turns between the primary and secondary windings of transformer 125 should be such that when the engine is running under its own power or at any speed above cranking speed, that the alternating current induced in the secondary should be of sufficient value to energize the relay 118 so as to keep apart the contacts 114 and 115. However when the periodicity of the interruption of the breaker arm 155 falls below such predetermined value or the engine speed is below cranking speed which may take place when the engine stalls, the value of the alternating current induced and flowing through the relay winding 118 should be insufficient to overcome the force of spring 117, whereby the armature contact 114 will be urged into engagement with stationary contact 115, thus re-establishing the connection of the electro-magnetic switch energizing winding 82 with the grounded post 104 through contacts 114 and 115 causing the energization of the starting motor to crank the engine.

The thermostatic element 89 and heating coil 109 serve as means to open the starting motor circuit and also re-establish the same after a short time interval whenever the engine does not act under its own power after a predetermined period of cranking of the motor.

The energization of the starting motor is periodically re-established due to the fact that the circuit for the flow of current to the heating coil 109 is dependent upon the position of bridge member 80 so that during the time that the same is out of engagement with contacts 77 and 78 or during the time that the starting motor is not in operation no current is flowing through the heating coil 109 thereby no heat is applied to the thermo-responsive element 89 permitting its cooling and causing the disengagement of contact 90 with the contact 91, thus interrupting the flow of current to the winding 98. The spring 117 will then cause the engagement of armature contact 114 with contact 115, re-establishing the current flow to the electro-magnetic

switch winding 82 for attracting the bridge member 80 into engagement with contacts 77 and 78, thus re-establishing a flow of current from the battery to the starting motor for cranking the engine. This cycle of operation or the automatic periodic cranking of the engine if the same does not become self-actuated, will take place for a predetermined period of time after which the thermostatic elements forming a part of the first control unit will operate rendering the starting motor and ignition system ineffective, and producing a signal or alarm.

The operation of the means to render the starting motor and ignition system ineffective after a predetermined number of cranking periods will be described: The connection of the battery to bus bar 24 will cause a flow of current to heating coil 26 connected thereto and having its other terminal connected by lead 28 to grounded terminal 29. The energization of heating coil 26 will raise the temperature adjacent to thermo-responsive member 27 whereby the latter will move causing the engagement of contact 33 and 67 thereby closing a circuit to cause the energization of heating coil 70 associated with thermo-responsive member 35. This energizing circuit comprises bus bar 24, through bimetallic member 66, contacts 67 and 33 to thermo-responsive member 27 hence by lead 69 to a terminal of heating coil 70 and from the other terminal by lead 71 to post 72 connected by lead 138 to terminal post 136 of the second control unit which is connected by lead 137 to stationary relay contact 115 normally in engagement with armature contact 114 connected by lead 112 to terminal post 104 grounded by lead 105, thus providing complete circuit for the flow of current through heating coil 70.

It should be noted that this circuit of the heating coil 70 is dependent upon the engagement of contacts 67 and 33 and of relay contacts 114 and 115. The engagement of the contact 33 with contact 67 is dependent upon the increase in temperature caused by the heating coil 26 and the rate of this increase is so arranged that there is a delayed action in the movement of thermo-responsive element 27 so as to permit a predetermined number of or at least the first cranking period of the starting motor before the contact 33 engages the contact 67.

The engagement of the relay contacts 114 and 115 is dependent and only takes place during the period of time that current is flowing to the starting motor and therefore heating action of coil 70 on thermo-responsive element 35 is dependent upon the duration of the flow of current to the starting motor or in other words the number of starting motor cranking periods are registered by the heating coil 70. The value of this current as well as the amplitude of movement of thermo-responsive member 35 upon a definite temperature rise can be regulated at will so that upon a predetermined number of cranking periods or upon a predetermined period of time the thermo-responsive element 35 is deflected causing the separation of contacts 34 carried thereby and contact 32 opening the circuit of the winding 38 of electro-magnetic switch 40 which in turn interrupts the circuit of the ignition system and of electro-magnetic switch winding 82 through the disengagement of contacting bar 42 with contacts 43 and 44, thereby rendering automatically the engine starting and ignition means ineffective.

The control system will produce a signal or

alarm indicating that the engine is not in operation whenever the starting motor and ignition means are rendered ineffective. This indication is produced as follows: Due to the connection of relay winding 47 to bus bar 24 the same will be energized whenever the battery is connected to bus bar 24 as this winding is permanently connected by lead 48 to the grounded terminal 29.

The energization of winding 47 will attract armature 60 causing the contact 61 carried thereby to engage contact 62, which is connected by lead 53 to stationary contact 56 the latter being in engagement with armature contact 55 whenever the relay winding 50 is not energized. The engagement of contact 61 and 62 will under such conditions establish a circuit for the energization of the bell 165 or other suitable alarm. This energizing circuit includes from the battery terminal 13 by leads 73 and 139 to terminal post 64 connected by lead 65 to contact 61 in engagement with contact 62, the latter being connected by lead 63 to contact 56 in engagement with contact 55 connected by lead 58 to post 59, the latter connected by lead 169 to a terminal of bell 165 having its other terminal grounded as at 167. The circuit for the alarm or bell 165 being controlled by the engagement of contacts 55 and 56 as well as that of contacts 61 and 62.

It is important to note that the relay contact 55 will be held in engagement with contact 56 by the action of spring 57 whenever the electro-magnetic switch 40 is in its open position, due to the fact that the relay winding 50 which serves to attract the armature 54 carrying contact 55 receives its current from the battery through the connection of lead 51 to the switch contact 44, so that no current is flowing through this relay winding when the contacting bar 42 is out of engagement with switch contacts 43 and 44.

The arrangement of connections described for the energization of the relay winding 50, is such that the contact 55 will be out of engagement with stationary contact 56 whenever current is flowing to the ignition system and to the electro-magnetic switch winding 82. Thus, no alarm or signal will be produced whenever the electro-magnetic winding 50 is energized, as the other relay contacts 61 and 62 forming part of this circuit will be in engagement due to the continuous flow of current through the relay winding 47 which is connected to bus bar 24 and to the grounded post 29. In this embodiment of the invention, I have used as a current source to produce the energization of signalling device 165 the storage battery 10. However, the terminal post 64 could be connected to any other independent source of current so that any other type of indicating means can be used, such as visual means as the invention is not limited to the use of audible means, as particularly shown by the bell 165.

In certain types of installation where more than one engine is used, the stationary post 59 is preferably connected to another set of controlling units so as to initiate the operation of a similarly arranged control system to the one disclosed for the purpose of starting a stand-by engine. It will only be required to connect the terminal post 59 to a post corresponding to post 19 of a similarly controlled system, so that the relay contacts 55 and 56 will take the place of the switch blade 15.

The means to stop the engine or render the same inoperative, which are dependent for their actuation upon improper temperature of the cool-

ing medium or improper level of the lubricating medium, by opening the operative connection of the battery to ignition system as well as to the switch winding 82, function in the following manner: The normally open switch element 170 will be moved to its closed position by means responsive to any of said abnormal conditions establishing a circuit to the heating coil 78 through the resistance 173. The flow of current through the coil 78 thus connected, will produce sufficient heat so that the thermo-responsive element 35 will be deflected moving the contact 34 out of engagement with stationary contact 32 opening the circuit of the electro-magnetic switch winding 38, de-energizing the electro-magnetic core 41 and moving the contact bar 42 out of engagement with stationary contacts 43 and 44, thus interrupting the flow of current from the battery to the ignition system whereby the engine will stop and also to switch winding 82. Concurrently with the opening of this circuit, the current flow to the relay winding 50 will be interrupted whereby engagement will take place between contacts 55 and 56, thus producing the energization of the signalling device or bell 165. It should be noted that the resistance 175 will limit the current flowing through the circuit including switch winding 82 which is also established when the switching element 170 is closed so that the magnetic flux produced by winding 32 will not be sufficient to move the core 81 for closing said switch.

The energizing circuit for the bell 165 will remain closed as long as any of these abnormal conditions are present because the flow of current through the heating coil 78 retains the thermo-responsive element 35 in its open position. However movement of switch blade 15 to open position will serve to de-energize the relay winding 47 causing the disengagement of contacts 61 and 52 which will open the circuit of the bell 165. The movement of blade 15 to open position will also open the circuit from the battery to the controlling means of the invention.

In the form of the embodiment shown, a bimetallic element is associated with each of the thermo-responsive elements for the purpose of compensating for any changes in ambient temperature, so that the movement of each of the thermo-responsive elements is dependent entirely upon the rising temperature caused by the heating coils, thereby increasing the reliability of the controlling system disclosed under all temperature conditions.

The control system of the invention by the use of means dependent for its operation upon the self-actuation of the engine, as hereinbefore pointed out, also operates as automatic means to crank the engine whenever the same stalls. In this respect it is important to note that the windings of the transformer and relay associated therewith are so designed that the same operate when the engine becomes self-actuated, taking advantage of the rapid rise in the voltage of the battery 10 when the engine becomes self-actuated, as the heavy load imposed by the starting motor while cranking the engine is not present at the instant the engine starts or becomes self-actuated.

The energization of the starting motor through this control is such that unless the engine stalls, the starting motor will not be connected to the cranking engine, thus preventing the possibility of applying the cranking motor while the engine is rotating.

The arrangement of the control system of the

invention is such that when the engine stalls, after it has been in operation, the number of cranking periods or power applications to the starting means is less before the engine is put out of operating condition, than when the engine is first started or when the control system is first placed in operation. This feature of the invention is accomplished due to the fact that during the time that the engine is in operation, the heating coil 26 is connected across the battery, whereby the contacts 33 and 67 are in engagement and the number of cranking periods before the engine is put out of operating condition is entirely controlled by the heating action of coil 70 which serves to deflect the thermo-responsive element 35 to open the circuit of the switch winding 33 by causing the disengagement of the contact 34 with contact 32. The flow of current through the heating coil 70, as hereinbefore pointed out, only takes place when the relay contacts 114 and 115 are in engagement, which condition exists whenever no current is flowing through the energizing windings of the relay 100, or in other words, during the time that power is applied to the starting motor through the use of electro-magnetic winding 82 which controls the bridging contact 80.

It is important to note that when the engine is first started, it will require several cranking periods or applications of power to the engine starting means before the heating coil 26 causes the deflection of the thermostatic element 27 to produce the engagement of contact 33 with contact 67 to establish the current flow to the heating coil 70.

In the form of the invention illustrated, I have shown the breaker mechanism of a battery ignition system for the purpose of interrupting the current flow through the primary winding 120 of transformer 125, and I contemplate the use of other circuit interrupting means functioning in response to the speed of the engine for causing the periodic interruption of this current flow, so that the invention can be well adapted to control the starting means used for Diesel engines wherein this type of breaker mechanism is not employed, as well as for use in connection with engines utilizing magneto ignition. In addition, the embodiment shown illustrates an electric starting motor as engine starting means, however, I contemplate the control system of the invention to be utilized for governing the functioning of valves or other apparatus which control the application of power to other types of engine starting means.

In the form of embodiment of the invention illustrated, I have shown diagrammatically three relays constituting elements of the controlling means of the invention. The relays can be of standard suitable type, however, I prefer to use a relay including a substantially balanced pivoted armature as particularly shown and disclosed in Williams Patent No. 2,021,396, issued November 19, 1935. I have found this type of relay very effective and reliable under all conditions of operation to which the system may be put.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than is herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

What I claim is:

1. In combination, engine ignition means; en-

gine starting means; electro-responsive means for controlling the operation of said engine ignition means and causing the periodic actuation of engine starting means; an auxiliary electric circuit normally open when said engine ignition means are in operation; and means including a thermo-responsive switch dependent upon the operation of said starting means for rendering said electro-responsive means ineffective to control the engine ignition means after a predetermined number of periodic actuations of said starting means and concurrently closing said auxiliary circuit.

2. In combination, a current supply; an engine ignition means; connections for establishing a current flow to said engine ignition means from said current supply; electro-responsive switching means and circuit connections therefor; manual switching means operable to establish a current flow to said electro-responsive switching means causing the energization of said ignition means through said connections from said current supply; and electro-actuated means associated with said electro-responsive switching means operable upon the presence of an abnormal engine operating condition to render the ignition means ineffective after said abnormal condition has been present for a predetermined period of time.

3. In combination, electro-responsive means operable to establish a flow of current for causing the energization of engine starting and ignition means from a source of current; switching means for connecting said electro-responsive means to a source of current; means including a thermo-responsive element associated with said electro-responsive means and being dependent upon the flow of current to said starting means for rendering the engine starting means ineffective after a predetermined period of time; and thermo-responsive means controlled by the operation of said thermo-responsive element for rendering said ignition means ineffective.

4. In combination, electro-responsive means adapted to establish an operative connection and causing the energization of engine starting and ignition means from a source of current; manual switching means for connecting said electro-responsive means to a source of current; and means including a timed element dependent upon the flow of current to said starting means for rendering said operative connection ineffective after a predetermined period of time when the engine is first started and for a different period of time when the engine is started after the same has been in operation.

5. In combination, a current supply; an engine starting means; normally open connections for establishing a current flow to said engine starting means from said current supply; electro-responsive means adapted to be connected to said current supply; manual switching means operable to establish a current flow to said electro-responsive means whereby a flow of current is established to starting means by closing said connections for a predetermined period of time; and means operable to establish the flow of current to said starting means for a shorter period of time when the engine stalls.

6. In combination, a current source; engine ignition means having conducting means for the flow of current thereto from a current source; an engine starting motor having conducting means for the flow of current thereto from a current source; an electro-magnet adapted to be

energized from said current source for establishing when energized an operative connection for the energization of said starting motor and said ignition means from said current source; means associated with said electro-magnet dependent upon the flow of current to said starting motor including a timed responsive element for causing the periodic actuation of said starting motor and rendering said operative connection ineffective after a predetermined number of periodic actuations; and electro-responsive means associated with said electro-magnet responsive to an abnormal engine operating condition for disconnecting said electro-magnet rendering said operative connection ineffective and maintaining the same in such condition.

7. In combination electro-responsive means and circuits therefor; switching means for connecting said electro-responsive means to a current source whereby an operative connection is established, causing the energization of a starting motor from a current source; means in the circuit of said electro-responsive means functioning in response to the self actuation of the engine for rendering said operative connection ineffective; and auxiliary means in association with said electro-responsive means including a plurality of timed elements for rendering said operative connection ineffective after different predetermined periods of time.

8. In combination, electro-responsive switching means and circuits therefor; manual switching means for connecting said electro-responsive switching means to a current source whereby an operative connection is established, causing the operation of an engine starting means; means responsive to the self actuation of the engine for disconnecting said electro-responsive means from the current source rendering said operative connection ineffective; and a thermo-responsive switch operable to disconnect said electro-responsive switching means from the current source after the starting means has been in operation for a predetermined period of time whereby said operative connection becomes ineffective, said thermo-responsive switch rendered operable to disconnect said electro-responsive switching means upon the presence of an abnormal engine operating condition whereby said operative connection becomes ineffective.

9. In combination, an electro-magnet and circuit therefor, said electro-magnet operable to close a normally open circuit; means for connecting said electro-magnet to a current source whereby the said normally open circuit is closed causing the energization of an engine starting motor from a current source; means functioning in response to the self actuation of the engine for disconnecting said electromagnet from the current source; auxiliary means including a timed element dependent for functioning in the flow of current to said engine starting motor for disconnecting said electromagnet from the current source after a predetermined period of time and re-establish the energization of said electro-magnet; and means dependent upon the function of said timed element to maintain said electro-magnet in its disconnected position.

10. In combination, electro-responsive means and circuit connections therefor; means for closing said connections producing the energization of said electro-responsive means from a current source whereby an engine starting means is actuated to start an engine; and means associated with said electro-responsive means de-

pendent upon the actuation of the engine starting means for causing the periodic operation of said starting means for a predetermined period of time.

11. In combination, electro-responsive means and circuit connections therefor; means for closing said connections for causing the energization of said electro-responsive means from a source of current; switching means operable by said electro-responsive means for causing the energization of an engine starting means; and means associated with said electro-responsive means for causing the periodic actuation of said switching means for a predetermined period of time.

12. In combination, electro-responsive switching means; normally open circuit connections for said means; manually operable switching means for closing said connections for energizing said electro-responsive switching means from a source of current, whereby an operative connection is established causing the operation of an engine starting means; means including an electro-responsive timed switching element associated with said electro-responsive switching means for periodically interrupting said operative connection if the engine starting means fail to start said engine; and a second electro-responsive means associated with said electro-responsive switching means responsive to a predetermined speed of the engine for rendering the operative connection for the engine starting means ineffective.

13. In combination, electro-responsive means; normally open circuit connections for said means; switching means for closing said connections for energizing said electro-responsive means from a source of current, whereby an operative connection is established causing the actuation of an engine starting means; thermo-responsive means associated with said electro-responsive means for periodically interrupting said operative connection; and a second means associated with said electro-responsive means and being responsive to the self-actuation of the engine for rendering said operative connection ineffective.

14. In combination, electro-responsive switching means operable to establish a flow of current for causing the energization of an engine ignition means from a source of current; electro-magnetic switching means operable by the actuation of said electro-responsive switching means for causing the energization of an engine starting means; means responsive to the self actuation of the engine for interrupting the energization of the engine starting means; and temperature compensated thermo-responsive switching means forming part of the circuit connection of said electro-responsive switching means and being dependent upon the flow of current to said starting means for rendering the electro-magnetic switching means and ignition means ineffective after a predetermined period of time current has been flowing to said engine starting means.

15. In combination, an electro-magnetic switch operable to establish a flow of current for causing the energization of an engine ignition means from a source of current; a second electro-magnetic switch operable by the actuation of said first electro-magnetic switch for causing the energization of an engine starting means; means responsive to the self actuation of the engine for stopping the operation of the second electro-

magnetic switch thereby interrupting the energization of the engine starting means; and means associated with said electro-responsive means functioning upon the flow of current to said starting means for stopping the operation of the first electro-magnetic switch thereby rendering the ignition means ineffective.

16. In combination, electro-responsive means operable to establish a flow of current for causing the energization of an engine ignition means from a source of current; electro-magnetic switching means operable by the actuation of said electro-responsive means for causing the energization of an engine starting means; means responsive to a predetermined speed of the engine for interrupting the energization of the engine starting means; and thermo-responsive means associated with said electro-responsive

means and being dependent upon the flow of current to said starting means for periodically causing the energization of said engine starting means and rendering the engine ignition means ineffective after a predetermined period of time.

17. In combination an engine ignition means; electro-responsive means for controlling the operation of said engine ignition means; manual switching means and circuit connections associated therewith for causing the energization of said electro-responsive means; and electro-actuated means associated with said electro-responsive means operable upon the presence of an abnormal engine operating condition to render the engine ignition means ineffective after said abnormal condition has been present for a predetermined period of time.

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