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L. K. LOEHR ET AL

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AUTOMATIC STARTING MECHANISM

Filed June 12, 1930

3 Sheets-Sheet 1

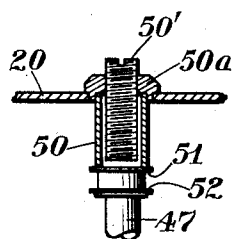
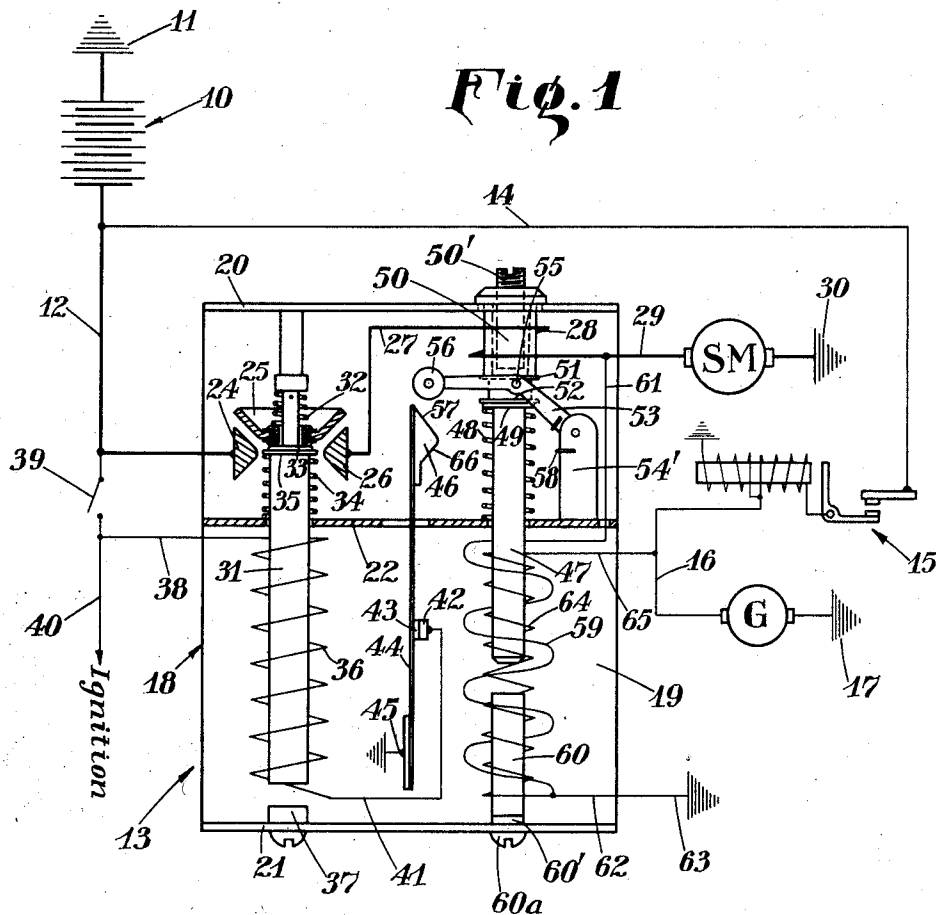


Fig. 9

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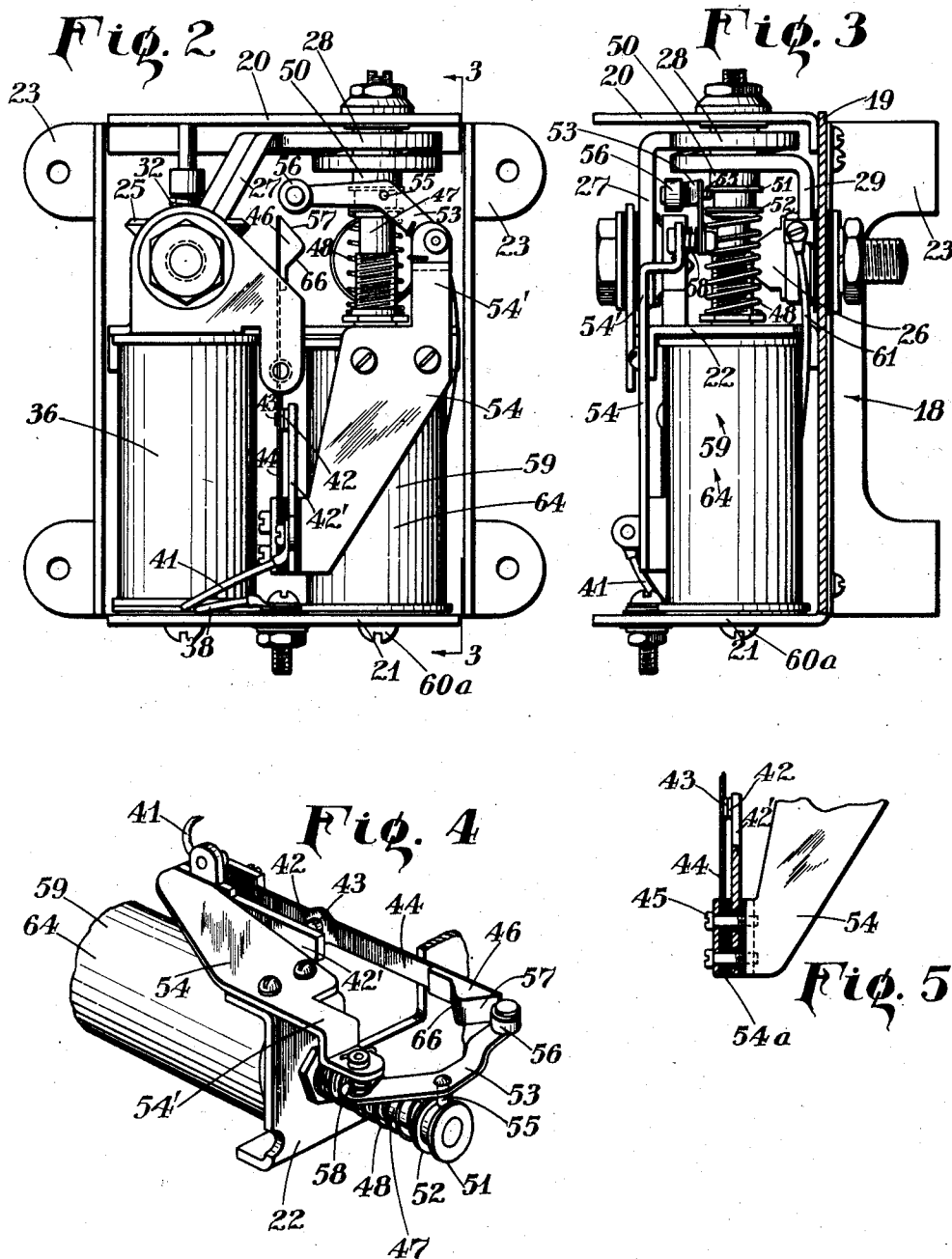
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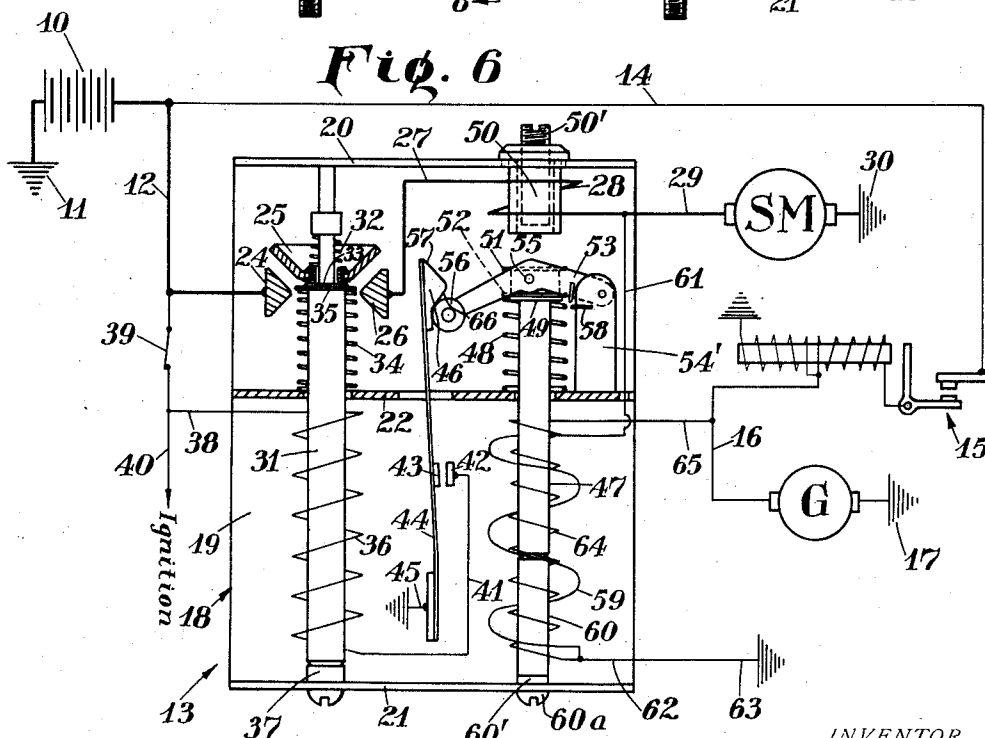
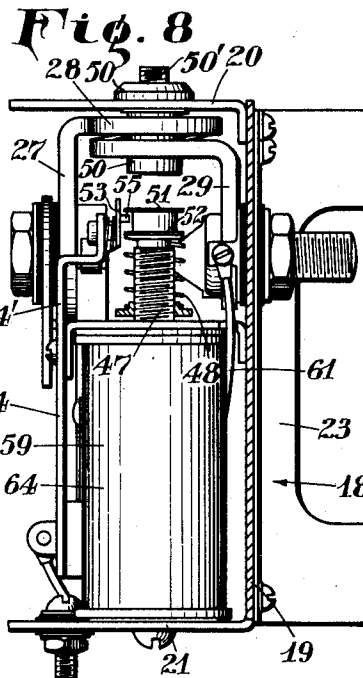
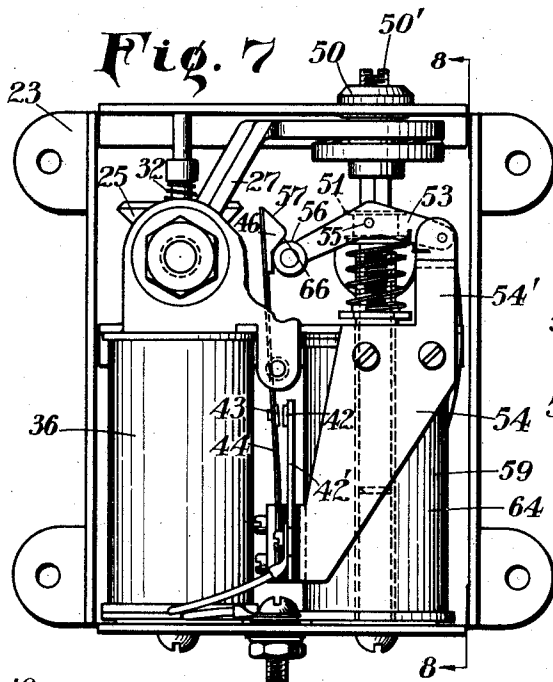
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AUTOMATIC STARTING MECHANISM

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3 Sheets-Sheet 3



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AUTOMATIC STARTING MECHANISM

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This invention relates to automatic starting systems for internal combustion engines, and more particularly to an improved device for automatically actuating the starter of an internal combustion engine upon closure of the ignition switch, and for restarting the same in case the engine stalls.

In devices of this character, it has been found desirable to incorporate some means to delay said restarting until the engine has come completely to rest. When an engine stops, particularly an engine having a small number of cylinders, it will often rock backwards and forwards a few times before finally coming to rest. If the starter should be engaged during the backward rocking of the engine, a severe and unnecessary strain is placed upon the starting mechanism.

In order to avoid this condition, it has been proposed to incorporate some form of time delay device in the automatic starting mechanism adapted to prevent the closure of the starting switch for a predetermined length of time. It is desirable that such a time delay device be unaffected by temperature, friction, battery voltage, moisture, oil, or magnetic variations in the coil of the starting switch.

Another function of the time delay is to prevent the operation of the automatic starting mechanism until the starting motor comes substantially to rest, even though the engine should make a false start and immediately stop before the generator has time to build up. This is desirable in order to secure a sufficient acceleration of the motor shaft on the next start to ensure the automatic meshing of the starter gear.

It is further desirable to have the time delay device operate from an element such as a relay which controls the starting switch rather than on an element of the starting switch itself. The former arrangement allows the initial start to be instantaneous and the delay is only effective during subsequent cycles of operation as long as the ignition switch is left on. An initial delay is of course unnecessary and merely time wasted.

It is an object of this invention to provide an automatic starting system for internal

combustion engines embodying a novel and improved time delay element.

Another object of the invention is to provide such a device in which the time delay element is substantially unaffected by the various conditions under which it is used.

A further object is to provide such a device which is not liable to get out of order or lose its adjustment during long periods of use.

Another object of the invention is to provide such a device including a starting switch and a control relay in which the time delay element is applied to the control relay rather than the switch plunger whereby the operation of the switch plunger is unimpeded.

A still further object of the invention is to provide such a device in which the time delay element is inoperative upon initial closure of the ignition switch, but is effective only in case of a restart immediately after the engine has stopped for any reason.

Further objects and advantages will be apparent to those skilled in the art from the following description taken in connection with the accompanying drawings in which:—

Fig. 1 is a semi-diagrammatic showing of the automatic starting mechanism illustrated in conjunction with a conventional electrical system for an internal combustion engine;

Fig. 2 is an elevation of the automatic starting mechanism per se;

Fig. 3 is a sectional view of the same taken substantially on the line 3—3 of Fig. 2;

Fig. 4 is a detail in perspective of the control relay device;

Fig. 5 is a detail of the control contacts;

Figs. 6, 7, and 8 are views corresponding to Figs. 1, 2, and 3 respectively, but showing the parts in the position assumed during the operation of the engine; and

Fig. 9 is an enlarged detail of the relay plunger stop.

In Fig. 1 there is illustrated an electrical starting system for an internal combustion engine including a battery 10, one terminal of which is grounded at 11 and the other

terminal of which is connected through a lead 12 to an automatic starting device indicated generally by numeral 13. The battery is also connected through a lead 14, automatic cut-out 15, and lead 16 to one terminal of a generator G, the other terminal of which is grounded as indicated at 17. It will be understood that the generator G is adapted to be mechanically connected in any suitable way to the engine to be started, not shown, whereby when the engine is running, the generator serves to charge the battery in the usual manner.

The automatic starting mechanism 13 is preferably mounted in a casing such as indicated at 18 comprising a base 19, end members 20 and 21 and a partition member 22. The base may be provided with depending leg members 23 as indicated in Figs. 2 and 3.

The starting mechanism comprises a starting switch 24, 25, 26, the member 24 of which is connected to the battery lead 12 and the member 26 connected through lead 27, single-turn coil 28 and lead 29 to one terminal of the starting motor SM, the opposite terminal being grounded as indicated at 30.

Switch member 25 is mounted on a plunger 31 of suitable magnetic material with provision for yielding longitudinal movement thereon in one direction against the pressure of a spring 32 which normally retains said switch member against a shoulder 33 on said plunger. The plunger is normally retained in the position shown in Fig. 1 with the switch member 25 out of contact with switch members 24 and 26 by a spring 34 located on the plunger 31 and compressed between a collar 35 on said plunger and partition member 22 of casing 18.

A solenoid coil 36 is fixedly mounted within the casing 18 surrounding the plunger 31 and arranged when energized to draw the plunger downward into contact with a pole piece 37 mounted on the end member 21 of the casing thus bringing switch member 25 into contact with switch members 24 and 26. One end of solenoid 36 is connected by means of a lead 38 to a manual switch member 39 which is connected to the battery through the lead 12. The switch 39 may also serve as the ignition switch for the engine, in which case a lead 40 extending from said switch is connected to the ignition devices, not shown.

The opposite terminal of solenoid 36 is connected through a lead 41 to a fixed contact 42 on an arm 42' rigidly mounted on a bracket 54 as indicated in Figs. 4 and 5, but insulated therefrom as shown at 54^a in Fig. 5. A movable contact 43 is mounted on an elastic conducting strip 44 one end of which is fixed to and grounded on the bracket 54 as by means of screws 45 traversing the arm

42' but insulated therefrom. The free end of said strip carries a weight member 46. It will be seen that the strip 44 with the weight 46 at its upper end comprises an inverted pendulum or vibrator the period of vibration of which depends on the stiffness and length of the strip 44, the size of the weight 46, the location of contact 42 and the normal pressure between contacts 42 and 43.

A control relay plunger 47 of suitable magnetic material is slidably mounted in casing 18 in generally parallel relation to the vibrator strip 44 and is normally held in its upper position as shown in Fig. 1 by means such as a spring 48 compressed between a collar 49 on said plunger and the partition 22 of the casing. The upper end of plunger 47 normally bears against a stop formed by a non-magnetic sleeve 50 suitably fixed in the end member 20 of casing 18. As illustrated more particularly in Fig. 9 of the drawings, this connection may take the form of a thimble 50^a of magnetic material having a press fit in the end member 20, and receiving the end of sleeve 50 with a press fit. Adjustably threaded within thimble 50^a is a pole piece 50' of magnetic material forming a core for the coil 28. It will be noted that sleeve 50 serves to magnetically insulate the plunger 47 from the pole piece 50' so that said plunger will not stick but will be withdrawn freely by coil 59 when the flux in single turn coil 28 is weakened by the starting of the engine. The plunger 47 is provided at its upper end with spaced shoulders 51 and 52 forming a channel therebetween. A lever 53 is pivoted at one end on an arm 54' extending upwardly from bracket 54 and carries near the middle portion thereof a pin 55 adapted to extend within the groove between shoulders 51 and 52, having considerable lost motion therebetween. The outer end of lever 53 carries a roller 56 which is normally in proximity to the upper inclined surface 57 of said weight member 46. A spring 58 is arranged to maintain the pin 55 against the upper collar member 51 when the relay mechanism is in its closed position as illustrated in Fig. 1.

A solenoid coil 59 is fixed in the casing 18 in any suitable manner, surrounding the solenoid plunger 47 and a pole piece 60 which is fixed to the end member 21 of said casing. Pole piece 60 is preferably magnetically insulated from the casing member 21 as by means of a non-magnetic washer 60' and is fixed to said member by suitable means such as a non-magnetic screw 60^a. Solenoid 59 is connected to the starting circuit by a lead 61 which taps into the lead 29, and is connected at its other end by a lead 62 to a ground connection 63. A second solenoid coil 64 is similarly arranged with respect

to the plunger 41, and may be arranged within the coil 59 as indicated in Fig. 1. Coil 64 is connected by a lead 65 to the generator lead 16 at one end, and at the other end is connected to the ground lead 62. Coil 59 is arranged when energized to draw the plunger 47 downward unless this action is prevented by the coil 28 of the starting circuit. Coil 64 is arranged to hold the plunger 47 in its lower position so long as the generator C is in operation.

Referring now in particular to Figs. 6, 7, and 8 of the drawings, it will be seen that when the plunger 47 is drawn downwardly, the shoulder 51 thereon will move the pin 55 downward thus swinging lever 53 and causing the roller 56 to engage the weight member 46 and bend the strip 44 backward, moving contact 43 away from the fixed contact 42, the roller 56 then engaging under the reversely inclined surface 66 of weight member 46. At this time, it will be noticed from reference to Fig. 6 that by reason of the inclination of the surface 66 with respect to roller 56 the lever 53 is moved downward slightly so that the pin 55 is spaced from the shoulders 51 and 52 of plunger 47 and the plunger is capable of some floating movement with respect to lever 53.

When the plunger 47 is released, shoulder 52 strikes against pin 55 and throws the lever 53 up to its normal position. This causes a sudden release of the weight 46 thus setting the strip 44 in vibration. The dimensions of coil 36 are so calculated that the time element of said coil is longer than the period of vibration of said strip 44 whereby coil 36 will not be energized to close switch member 25 until the vibrator has come substantially to rest. The precise relationship of the self-inductance of the coil 36 to the applied voltage, flux and counter E. M. F. is not deemed of importance in this disclosure. In this connection it is simply to be understood that the self-inductance is made sufficiently great so that the time necessary to build up the flux in the coil to an effective value is greater than the time that contacts 42, 43 remain closed when the strip 44 is in vibration.

In operation, when the operator closes the ignition switch 39, the circuit is completed from battery 10 through lead 12, switch 39, lead 38, coil 36, lead 41, contacts 42 and 43 to the ground at 45. The consequent energization of coil 36 moves plunger 31 downward closing the starting switch 24, 25, 26. This closes the starting circuit from battery 10 through lead 12, switch members 24, 25, 26, lead 27, coil 28, and lead 29 to the starting motor SM and from thence to the ground at 30. Coil 59 is also energized at this time through lead 61 from the starting circuit lead 29 and through lead 62 to the ground at 63. However, during the starting opera-

tion, the coil 28, energized by the heavy starting current prevents the retraction of plunger 47 and retains it in its upper position.

When the engine starts, the load on the starting motor is relieved thus causing a large reduction in the current traversing coil 28 and raising the voltage applied to coil 59. This allows coil 59 to overcome the action of coil 28 and spring 48, drawing plunger 47 downward and moving contact 43 to its open position as shown in Figs. 6, 7, and 8. Coil 36 is thus deenergized and plunger 31 is moved to its upper position by means of spring 34, thus opening the starting circuit. Plunger 47 is not immediately released however since coil 59 retains sufficient magnetism to hold the plunger in its lower position by reason of a small amount of current generated by the rapid spinning of the armature of the starting motor in its residual field. Meanwhile, the generator G being driven by the engine builds up sufficient voltage to retain the plunger 47 in its lower position by means of coil 64 as long as the engine operates.

Should the engine stop for any reason while the switch 39 remains closed, coil 64 becomes deenergized and plunger 47 is moved by spring 48 to its upper position, thus releasing the weight 46. Since weight 46 is set in vibration by the releasing action, contact 43 will open and close the circuit through coil 36 for a predetermined length of time before coming to rest against contact 42. During this time, the coil 36 is not effectively energized since its design is such that the counter electromotive force generated by the building up of flux in the coil delays the energization of the coil 36 and the contacts reopen before an effective flux has been built up. The vibrating element 44 is so designed that this time delay is sufficient to allow the engine to come completely to rest before reengagement of the starting switch member 25.

In case the engine makes a false start and then stops after the first explosion or two, the relay plunger 47 is opened by the relief of the load on the motor, but the generator G does not have time to build up and operate coil 64 to retain the plunger open. However, the coil 59 will, as stated above, retain plunger 47 in open position till the motor comes substantially to rest. The current supplied to coil 59 then becomes insufficient to hold the plunger 47 down, so that it springs up, closing the circuit of coil 36, and the starting operation is repeated.

It will be readily appreciated that the form of time delay, herein described, depending as it does on the duration of oscillation of a damped vibratory element, is substantially unaffected by operating conditions of the automatic starter. Moreover, since

the time delay is not applied to the starter switch itself, it is evident that an initial start is not delayed thereby, and the motion of the switch plunger is unimpeded thus promoting a quick and positive closing and opening of the starter circuit. It will also be noted that the length of travel of the starter switch plunger may be reduced without affecting the operation of the device, thus permitting a reduction in the size and capacity of the switch solenoid.

Although but one embodiment of the invention has been shown and described in detail, it will be apparent to those skilled in the art that other embodiments are possible and certain changes may be made in the arrangement and proportions of the parts and certain features may be omitted or altered without departing from the spirit of the invention.

Reference will therefore be had to the claims hereto appended for a definition of the scope of the invention.

What is claimed is:—

1. In an automatic starting and ignition system for internal combustion engines, an ignition circuit including an ignition switch, an electrical starting circuit, a switch for opening and closing said starting circuit, a solenoid in circuit with the ignition switch of the engine adapted when energized to close said starting switch, a pair of contacts in circuit with said solenoid, means to move one of said contacts to open position when the engine starts and to hold said contact open as long as the engine runs under its own power, and means to prevent the effective energization of the solenoid until a predetermined time after the initial movement of said contact to closed position.

2. In an automatic starting system for internal combustion engines, an electrical starting circuit, a switch for opening and closing said circuit, a solenoid adapted when energized to close said starting switch, a pair of contacts in circuit with said solenoid, means to move one of said contacts to open position when the engine starts and to hold said contact open as long as the engine runs under its own power, and means to vibrate said contact a predetermined length of time before effective closure thereof.

3. In an automatic starting system for internal combustion engines, an electrical starting circuit, a switch for opening and closing said circuit, a solenoid in circuit with the ignition switch of the engine adapted when energized to close said starting switch, a pair of contacts in circuit with said solenoid, means to move one of said contacts to open position when the engine starts, and to hold said contact open as long as the engine runs under its own power, said contact being so mounted that upon its release it will vibrate a predetermined length of time be-

fore coming to rest against the cooperating contact.

4. In an automatic starting system for internal combustion engines, an electrical starting circuit, a switch for opening and closing said circuit, a solenoid in circuit with the ignition switch of the engine adapted when energized to close said starting switch, a pair of contacts in circuit with said solenoid, means to move one of said contacts to open position when the engine starts, and to hold said contact open as long as the engine runs under its own power, said contact being so mounted that upon its release it will vibrate a predetermined length of time before coming to rest against the cooperating contact, the electrical constants of said solenoid being such that it will not become effectively energized until the movable contact comes substantially to rest.

5. In an automatic starting and ignition system for internal combustion engines, an ignition circuit including an ignition switch, an electrical starting circuit, a switch for opening and closing said circuit, a solenoid in circuit with the ignition switch of the engine adapted when energized to close said starting switch, a pair of contacts in circuit with said solenoid, means to move one of said contacts to open position when the engine starts and to hold said contact open as long as the engine runs under its own power, said contact being pendulously mounted so that upon the release thereof it will vibrate a predetermined length of time before coming to rest against the cooperating contact, the period of vibration of said pendulum being greater than the time constant of the switch solenoid.

6. An electrical system for internal combustion engines including an ignition switch, an electrical starting circuit including a starting switch, magnetic means in circuit with said ignition switch adapted, when energized, to close the starting switch, means including a relay adapted to deenergize said magnetic means when the engine starts and to maintain said magnetic means deenergized until the engine comes substantially to rest and means causing initial reclosure of the relay to set up a pulsating current through the magnetic means for further delaying the effective reenergization of said magnetic means to allow the engine to come completely to rest.

7. In an automatic starting mechanism for internal combustion engines, a starting circuit including a magnetic starting switch, a control circuit for said starting switch including circuit making and breaking means, means for holding said making and breaking means open during self-operation of the engine, and means whereby the release of said holding means sets up for a predetermined time interval a pulsat-

ing current which is ineffective to energize the magnetic starting switch.

8. In an automatic starting mechanism for internal combustion engines, a starting circuit including a magnetic starting switch, a control circuit for said starting switch including circuit making and breaking means, an electromagnetic coil in series in the starting circuit effective during cranking to maintain said making and breaking means closed, means for opening said making and breaking means responsive to the release of the cranking load when the engine starts, means for holding said making and breaking means open during self-operation of the engine, and means whereby initial reclosure of the making and breaking means is prevented from effectively energizing said magnetic starting switch for a predetermined time interval.

9. In an automatic starting mechanism for internal combustion engines, a magnetic starting switch, a control circuit for said starting switch including a pair of contacts, means responsive to self-operation of the engine for holding said contacts open, and means causing said contacts to vibrate a predetermined time before effective closure thereof.

10. In an automatic starting mechanism for internal combustion engines, a magnetic starting switch, a control circuit for said starting switch including a pair of contacts, one of which is movable, means for moving said contact to open position and means for vibrating said contact a predetermined time after release thereof.

11. In an automatic starting mechanism for internal combustion engines, a magnetic starting switch, a control circuit for said starting switch including a pair of contacts, one of which is movable, means for moving said contact to open position and for holding said contact open during self-operation of the engine, said contact being pendulously mounted whereby upon release thereof it will be vibrated a predetermined length of time before coming to rest in engagement with the cooperating contact.

In testimony whereof we have signed this specification.

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