Nov. 19, 1935. W. J. WILLIAMS 2,021,396

STARTING MOTOR AND IGNITION SYSTEM CONTROL FOR INTERNAL COMBUSTION ENGINES

Filed July 24, 1933 2 Sheets-Sheet 1

Fig. 1.

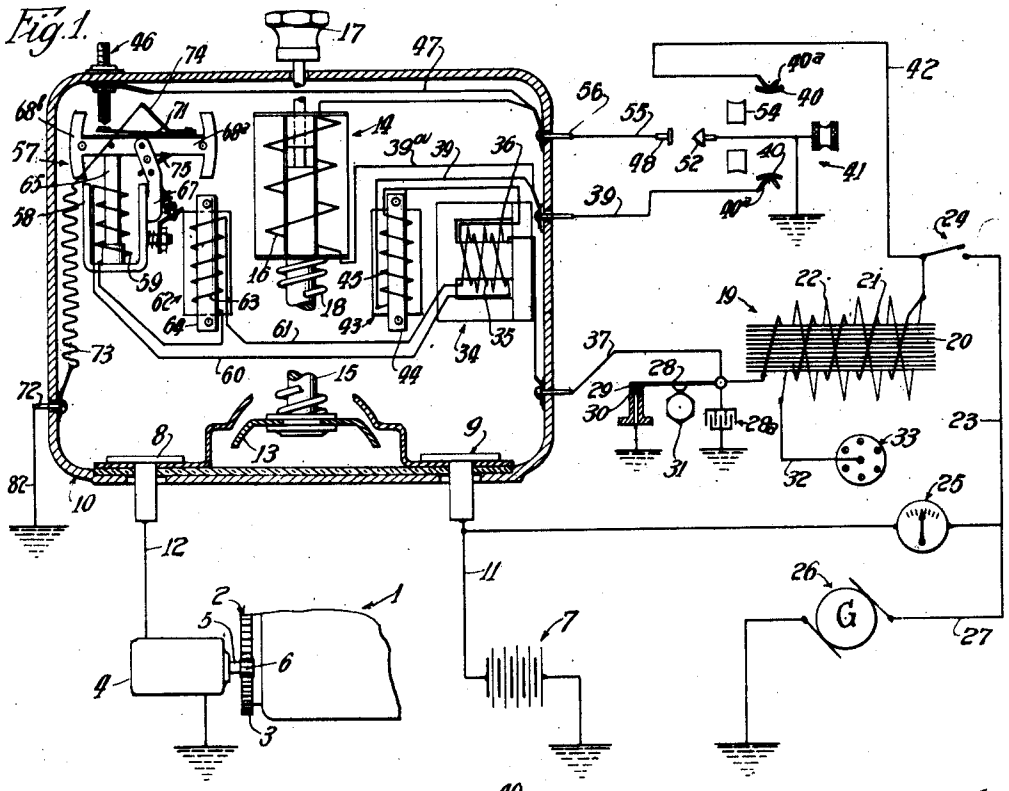


Fig. 4.

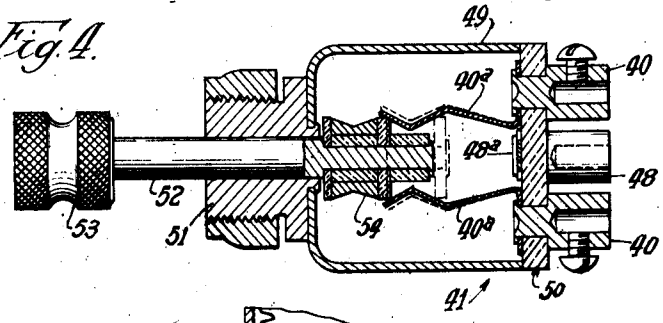
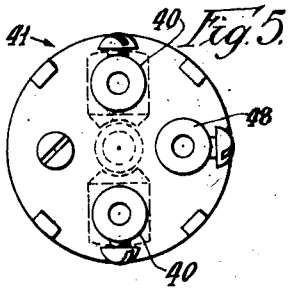


Fig. 5.



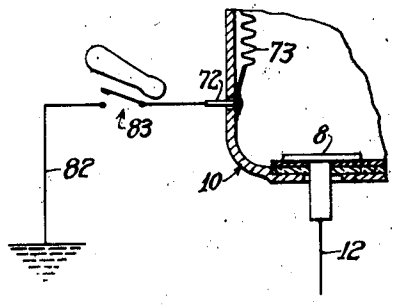


Fig. 7.

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STARTING MOTOR AND IGNITION SYSTEM CONTROL FOR INTERNAL COMBUSTION ENGINES

Filed July 24, 1933 2 Sheets-Sheet 2

Fig. 2.

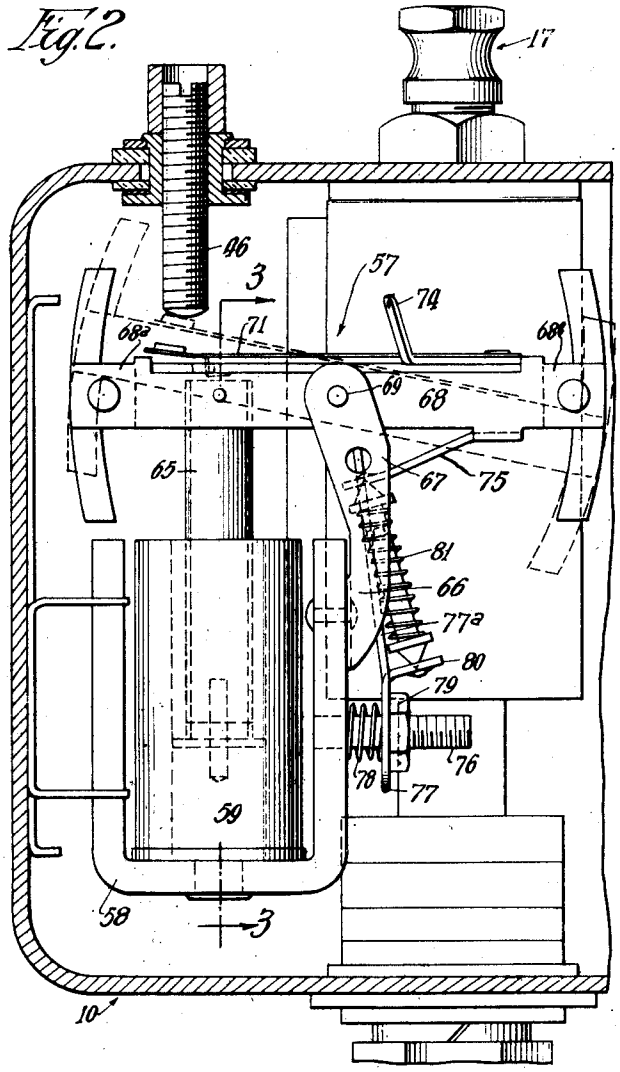


Fig. 3.

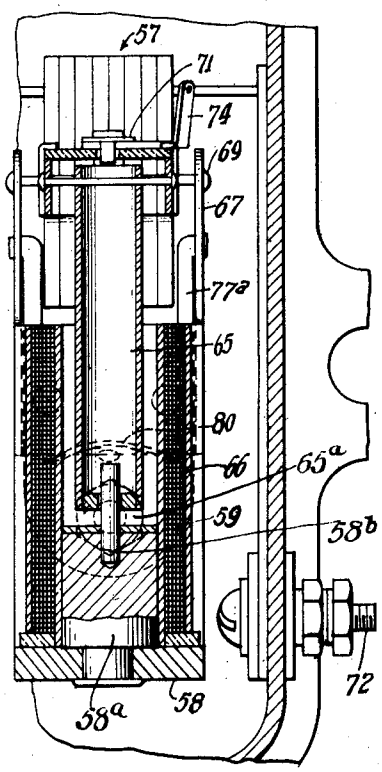
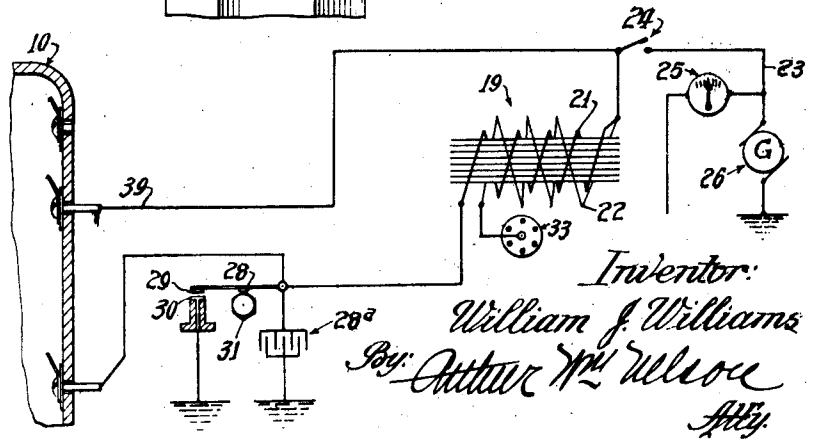


Fig. 6.



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UNITED STATES PATENT OFFICE

2,021,396

STARTING MOTOR AND IGNITION SYSTEM CONTROL FOR INTERNAL COMBUSTION ENGINES

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Application July 24, 1933, Serial No. 681,948

11 Claims. (Cl. 290—37)

This invention relates to improvements in starting motor and ignition system control for internal combustion engines and it consists of the matters hereinafter described and more particularly pointed out in the appended claims.

One of the objects of the present invention is to provide a control for the starting motor which operates automatically at an engine speed below a predetermined low speed thereof just before it stops, to restart the same by operatively engaging the still moving fly wheel and imparting a turning movement thereto, thus saving wear and tear on the operating parts as well as battery current.

Another object of the invention is to provide a system of this kind wherein the starting motor is intimately hooked up with the ignition and is controlled mainly through the breaker point mechanism, thus eliminating troubles that are inherent when the starting motor system is controlled by the function of the usual engine driven generator as is now usually employed on the modern automobiles.

Another object of the invention is to provide a control system of this kind wherein the starting motor mechanism may be easily disconnected from the ignition so that the engine may be cranked or turned over manually for starting as is often desired in servicing operations.

The above mentioned objects of the invention as well as others, together with the many advantages thereof will more fully appear as I proceed with my specification.

In the drawings:

Fig. 1 is a diagrammatic view illustrating the preferred form of the improved control;

Fig. 2 is a view in side elevation on an enlarged scale of a certain relay circuit breaker forming a part of the invention and which will be more fully referred to later.

Fig. 3 is a vertical sectional view through a part of the relay circuit breaker as taken on the line 3—3 of Fig. 2;

Fig. 4 is a longitudinal vertical sectional view through a control switch embodied in the system;

Fig. 5 is a view in end elevation of the switch shown in Fig. 4;

Fig. 6 is a detail diagrammatic view illustrating a modified form of the invention where the manually operable remote control switch has been eliminated; and

Fig. 7 is a detail diagrammatic view illustrating a further modified form of the invention and which will be more fully referred to later.

Referring now in detail to that embodiment of the invention, illustrated in the accompanying drawings and particularly to Fig. 1 thereof:

1 indicates as a whole the engine to be started and which engine includes a fly wheel 2 having teeth 3 thereon. 4 indicates an electric starting motor mounted in operative relation to the engine fly wheel. Said motor includes a shaft 5 with a pinion 6 thereon. When the motor is energized this pinion is caused to travel endwise of said shaft into operative engagement with the teeth 3 of the fly wheel to drive the same. When the engine is started, it drives and repels the pinion out of operative engagement therewith.

7 indicates a source of electrical energy such as a battery and which is grounded at one side as shown. 8 and 9 indicate a pair of spaced contacts arranged within a casing 10 that encloses certain parts for the automatic control of the starting motor. The contact 9 is connected by a conductor 11 to the other side of the battery while the contact 8 is connected by a conductor 12 to one side of the starting motor, the other side of which is grounded as shown.

Associated with said contacts 8 and 9 is a movable contact 13 forming a part of an electromagnetic switch 14 arranged within the casing 10. The contact 13 is carried on the bottom end of the armature or plunger 15 of said switch which extends through a coil winding 16. The top end of the plunger extends through the top wall of the casing and is provided with a knob 17 for grasping in manual operation. A spring 18 surrounds the plunger between the contact 13 and coil 16 and normally acts to hold the contact 13 out of engagement with the contacts 8 and 9.

When the contact 13 is in the position shown in Fig. 1 wherein it is out of engagement with the contacts 8 and 9, the starting motor remains deenergized. When the plunger has been attracted up into the coil 16 upon energization thereof, the contact 13 engages both contacts 8 and 9 and operatively connects the motor with the battery for the energization of the motor. When the coil 16 is deenergized, then the spring 18 serves to break the engagement of the contact 13 with the contacts 8 and 9 and the motor 4 stops.

Associated with the engine is an ignition system which includes a coil 19 comprising a core 20 and primary and secondary windings 21 and 22 respectively. One end of the primary winding is connected by a conductor 23 to the conductor 11 and in said conductor 23 are interposed, a main ignition switch 24 and an ammeter 25

respectively. A generator 26 adapted to be driven by the engine 1, is connected by a branch 27 to the conductor 23 between the switch 24 and ammeter 25.

The other end of the primary winding 21 is connected to a vibratable spring arm 28 carrying a contact 29 at its free end for movement toward and away from a grounded fixed contact 30. The arm 28 is arranged in operative relation with respect to a rotatable cam 31, which together with the arm and contacts mentioned constitute the breaker mechanism of the ignition system. The cam of course, is rotatively driven in direct proportion with the speed of the engine. The usual condenser 28a is associated with the vibrator arm 28 and winding 21 for the purpose well known.

One end of the secondary winding is connected to the primary winding while the other end of the secondary winding is connected by a conductor 32 with the center terminal of a current distributor 33. This distributor is operatively connected to the various spark plugs (not shown) of the engine 1.

Within the casing 10 is located a transformer 34 that includes a primary winding 35 and a secondary winding 36. One end of the primary winding of said transformer is connected by a conductor 37 with the arm 28 while the other end of said primary winding is connected by a conductor 39 with one of a pair of terminals 40 of a certain switch 41 later to be described. The other contact of said pair of contacts is connected by a conductor 42 with the conductor 23 at a point between the ignition coil 19 and switch 24 respectively.

Associated with the primary winding of the transformer is a choke coil 43 including a core 44 and a winding 45 with the latter interposed in the conductor 39.

Arranged in the top wall of the casing is an adjustable cut out contact 46 that is connected by a conductor 47 to a terminal 48 forming the third fixed contact of the switch 41. One end of the winding 16 of the electromagnetic switch 14 is suitably connected to the conductor 47 while the other end of said winding is connected by a branch 39a to the conductor 39 at a point between the terminal 40 and winding 45 of the choke coil 43.

The switch 41 as best shown in Figs. 4 and 5 includes a casing 49 closed at one end by a plate 50 of non-conducting material and which carries the pair of terminals 40 and the terminal 48. In the other end of the casing is a bushing 51 through which slides a stem 52 having a knob 53 on that end beyond the bushing 51.

Associated with the terminals 40 but arranged within the casing is a pair of laterally spaced spring finger contacts 40a and associated with the terminal 48 and arranged between the contacts 40a is another contact 48a. It is to be noted that the free ends of the contact fingers 40a are veed toward each other for operative engagement in opposite sides of a grooved collar 54 that is mounted upon but is insulated from the stem 52.

When the parts are in the position shown in full lines in Fig. 4, the fingers 40a are engaged with a part of the insulation that insulates the collar 54 from the stem 52 and said contacts are electrically disconnected. When the stem 52 has been moved inward to a position wherein the fingers engage opposite sides of the part of smallest diameter of the collar 54, the fingers are electrically connected through said collar. When the stem is pushed further inwardly into the casing so that the end of the stem engages the contact 48a, the fingers 40a will engage with the outer end part of larger diameter of the collar 54 so as to still be electrically connected through said collar.

The terminal 48a is connected by a conductor 55 with a terminal 56 in the casing 10 and to which the conductor 47 and one end of the coil 16 are each operatively connected.

When the stem 52 is in the full line position shown in Fig. 4 the switch is in its "off" position. When the stem 52 has been pushed inwardly so that the fingers 40a engage opposite sides of the part of smallest diameter of the collar, energy passes from the battery, through the switch 24 (when closed) line 42, contact fingers 40a and collar 54, line 39 to the choke coil 43 and transformer 34. When the stem is pushed inwardly to its limit, wherein the end of the stem 52 engages the contact 48a and the contact fingers 40a engage opposite sides of the outer end part of larger diameter of the collar 54, this operatively connects the line 55 with the stem 52 that is grounded to the casing 49, the contact fingers 40a still being electrically connected through the collar 54. When the stem is released, the action of the fingers 40a on the collar 54 is such as to return the stem to its normal position wherein the fingers 40a engage opposite sides of the part of smallest diameter of the collar. The parts will remain in this position until the stem 52 is pulled outwardly to return the parts to the "off" position shown in Fig. 4.

Should it be desired to omit the switch 41 and the remote controlled features afforded thereby, the line 39 is connected to the ignition switch 24 and the line 55 omitted as shown diagrammatically in Fig. 6.

Within the casing is located a relay switch of peculiar construction, indicated as a whole by the numeral 57. This relay switch includes a U-shaped bracket or support 58 that is operatively secured to the casing 10 in any suitable manner. Between the side arms of the support is provided a coil 59, one end of which is electrically connected by a conductor 60 with one end of the secondary winding 36 of the transformer. The other end of said coil 59 is electrically connected with the other end of said secondary winding by a conductor 61. In the bottom of the coil and fixed to the bottom cross member of the U-shaped bracket or support 58 is a magnet stud 58a (see Fig. 3). Near the coil 59 is provided a choke coil 62 that includes a winding 63 and a core 64, the winding being interposed in the line 61.

Associated with the coil 59 of the relay so as to be attracted or moved thereinto when said coil is energized, is a tubular armature or plunger 65. The bottom end of said plunger 65 which is closed has a guided engagement with a pin 58b rising from the magnet stud. The plunger 65 is so proportioned in length as to normally leave an air gap 65a (see Fig. 3) between the bottom end of said plunger and the magnet stud. A bracket 66 is fixed to one side of the support 58 and said bracket includes an upstanding bifurcated yoke 67. A balanced lever 68 is disposed between the spaced arms of the yoke 67 and is pivoted at its mid portion to said arms of the yoke as at 69. The arms 68a—68b of the lever carry arcuate balancing weights as shown and on the top of said lever is provided a spring contact finger 71 for engagement with and disengagement from the

contact 46. In the adjacent side of the casing is a terminal 72 that is connected by a pigtailed conductor 73 with an arm 74 forming a part of the contact 71. By means of said conductor the lever is capable of a movement with respect to the terminal 72 without impairing the electrical connection between the two.

The plunger 65 is operatively connected at its top end to the arm 68a of the lever and the arm 68b of the lever carries an inwardly and downwardly directed arm 75 that extends between the spaced arms of the yoke 67. Secured to that side of the bracket 58 to which the yoke 67 is secured, is a threaded stud 76. On the same is mounted one end of an adjustment member 77, the other end of which is made as spaced arms 77a operatively engaged with the arms of the yoke 67. A spring 78 surrounds the stud between the support and the member 76 and a nut 79 is threaded on the stud so as to engage said member. By manipulating this nut, the angular position of the adjustment member 77 may be regulated. The member 77 includes an ear 80 and between said ear and the arm 75 is suitably engaged a light expansion spring 81. It is pointed out that the line of force of said spring is so disposed as to normally swing the lever arm 68a upwardly to hold the contact 71 in engagement with the contact 46 when the coil 59 is deenergized.

The terminal 72 is suitably grounded by a conductor 82 as shown in Fig. 1. If desired, a switch 83 may be arranged in said conductor as shown in Fig. 7 and this switch may be actuated from the accelerator pedal of the associated engine or from any other convenient pedal.

With the system comprising the parts as shown in Fig. 1, assume that it is desired to start the associated engine 1. When the switch 24 is closed and the stem 52 of the remote control switch 41 is pushed partway in, current from the battery flows through the switch 24, line 42, switch 41, branch 39a, coil 16 of the switch 14, to the terminal 56. From there, it passes through the conductor 47, engaged contacts 46 and 71 through the pigtailed conductor 73, terminal 72 and conductor 82 to the ground.

This closed circuit energizes the coil 16 to attract the plunger 15 against the action of the spring 18 to cause contact 13 to engage the contacts 8 and 9. Current from the battery then flows from the contact 9 across the contact 13 to contact 8 and through the conductor 12 to the starting motor 4 which becomes energized.

With the motor thus energized, its pinion 6 advances on the shaft 5 into operative engagement with the teeth 3 on the engine fly wheel 2 which is driven by said pinion to start the engine. When the engine is running under its own power, the fly wheel 2 drives the pinion 6 which is repelled or moved out of operative engagement therewith. Of course, with the engine in operation, the breaker cam 31 will operate to vibrate the arm 28 in direct proportion to engine speed.

In the vibration of said arm, current passing through the primary winding 21 of the ignition coil is interrupted and this induces a high tension current in the secondary winding 23 of said coil which is fed to the spark plugs (not shown) of the engine by the distributor 33.

As the primary winding 35 of the transformer is in circuit with the arm 28, the interruptions or pulsations produced in said circuit by said arm 28 and the cam 31, are effective upon said primary winding 35 and the associated choke coil 43.

This circuit interruption or pulsation in the primary winding of the transformer induces a current in the secondary winding 36 of the transformer, and associated choke coil 62, the value of which varies as the speed of the interruptions or pulsations in turn dependent upon engine speed.

It is apparent that current produced by the secondary coil of the transformer is an alternating current. With the engine running under its own power at a minimum idling speed above that speed termed "cranking speed" as when the engine is being turned over by the starting motor, said current is built up to a value in the coil 59 of the relay which can attract the plunger 65 into the coil against the moment of inertia of the lever 68 and the action of the spring 81.

With the lever construction described, the pulsations of the current as it passes through the coil are ineffective to cause a fluttering of the lever 68 due to the moment of inertia of said lever but so soon as the current value builds up in said coil, this overcomes the action of the air gap 65a and the plunger is attracted into the coil. The lever 68 then swings counterclockwise around its pivot 69 to cause the contact 71 to leave the contact 46. This breaks the circuit for the coil 16 of the magnetic switch which becomes deenergized when the spring 18 comes into operation to break the connection between the contacts 8 and 9. When such contact has been broken this disconnects the starting motor from the battery and the starting motor stops, the engine of couse, still running under its own power.

It is pointed out at this time that by means of the adjustment afforded by the contact 46 and by the nut 79 on the screw or stud 76 of the relay, the operation of the relay may be regulated or controlled. In other words, the relay may be adjusted to cut in and out at the desired engine speeds. For instance, by reason of the construction of the relay, it may be adjusted to break the starting motor circuit at an engine speed of about 250 R. P. M.'s and to again remake the same at an engine speed of say 100 R. P. M.'s, which is below its lowest pulling speed. Thus it cuts in at a speed much lower than when it cuts out. This is due to the presence of the air gap 65a which requires more current to pull the plunger down toward the stud 58a to overcome said air gap, than is required to thereafter hold it down.

It is pointed out that engine speed when the same is being cranked by the starting motor is much lower than engine idling speed and this cranking speed is not fast or high enough to produce interruption in the relay circuit having a current value that will actuate the same.

Thus just before the engine stops, as when stalling, the current value in the coil 59 being insufficient to hold the armature attracted, the spring 81 swings the lever 68 in a clockwise direction to again cause the contact 71 to engage the contact 46 and reestablish the circuit for the switch 14 which again becomes energized. When thus energized, it attracts its plunger 15 to cause the contact 13 to bridge and operatively connect the contacts 8 and 9 to reestablish the starting motor circuit. With this circuit reestablished the motor again cranks the engine.

It is pointed out that the starting motor circuit is reestablished before the engine stops so that the pinion 6 picks up the still moving fly wheel. It is apparent that with the restarting operation occurring when the engine is still turning over, the restarting is made much easier and

with a less strain on the starting motor and battery. Again, at this time, tooth speed of the starter pinion is substantially equal to that of the fly wheel ring gear so that pinion engagement therewith is quiet and easy.

The lever 68 due to its construction and mounting in connection with the arrangement of the spring 81 has a moment of inertia and the effect thereof provides the time factor necessary to bridge the gaps between power impulses fed to the relay coil. Thus when these impulses are in accordance with engine idling speed as when produced by the action of the cam 31 on the arm 28 their periodicity is such as to hold the relay coil energized. With the coil thus energized, the lever 68 is maintained in a position holding the starting motor circuit open.

When the engine speed falls below idling speed, as when approaching a stall or stop, the pulsations delivered to the relay coil are so infrequent that the coil is deenergized with the result that the lever 68 swings clockwise to bring its contact 71 into engagement with the contact 46 to again close the circuit for the starting motor switch which again operates to energize the motor to restart the engine and this occurs before the fly wheel stops its rotation.

It is apparent that the operation of the control for the starting and stopping of the starting motor is controlled by the breaker point mechanism. This mechanism is the most reliable mechanism of the vehicle in which it is installed and must be taken care of if vehicle operation is desired. Thus so long as the breaker point mechanism will permit vehicle operation, it is efficient enough to control the relay.

It might be found desirable at some time to close the circuit to the coil 16, independent of the relay. To do this, the stem 52 of the switch 41 is pushed to its inmost position, when the stem 52 engages the contact 48. Thus with the ignition switch 24 closed, a circuit is established from the battery 7, through switch 24, coil 19, transformer 34, coil 43, lead 39, branch 39a, coil 16, conductor 47, terminal 56, conductor 55, contact 48, stem 52 to the ground of the switch 41. Pulling outwardly on the stem 52 to one position, breaks engagement between the stem 52 and contact 48 and returns the system to its condition to operate automatically in restarting.

With such a starter control system hooked up with the ignition system, there is an induction effect on the ignition and for the purpose of improving the results of this effect, the choke coils 43 and 62 are interposed in the primary and secondary circuits of the transformer 34.

As before described, the winding 45 of choke 43 is in circuit with the primary winding 35 of the transformer 34. The number of turns and size of wire in the coil 45 of the choke 43 are such that the flux density of said choke 43 causes an improved effect on the ignition.

From the arrangements of circuits it will be seen that the primary transformer circuit builds up at the same time as does the ignition primary and they both break down at the same time and both receive an induced current in the same direction which would tend to cause more current to flow in that direction.

By inserting the choke coil 43 as described and which coil has a greater inductance than that of the transformer, the reversal of the induced current of the choke coil causes the magnetic field of the ignition coil to break down faster, thereby changing its time factor, which in turn causes a higher inductance in the secondary winding of the ignition coil, causing it to give a more efficient spark and to operate at higher speeds. Due to this improved effect, better operation is had of the engine, saving fuel and increasing the power.

Interposed in the secondary circuit of the transformer is another choke coil 62 which causes a still further improved effect on the ignition.

The peak of the flux density of this choke occurs at a different time than that of the primary circuit choke 43 and the turn ratio of the winding or coil 63 of the choke 62, together with the winding 59 of the relay 57, are such that they deliver an induced current which is reverse to that of the secondary winding 36 of the transformer with the result that it induces a current in the primary of the transformer in the direction of the flow of charge. Inasmuch as this primary winding circuit is in parallel with the primary of the ignition coil, a more complete charge or saturation of the two primaries is had and due to the faster time factor of the flux breakdown, more time is had for complete saturation of the ignition coil, resulting in improved ignition.

This effect is produced by the difference in winding ratios of the choke coils, or reactance coils, with respect to their associated windings and the combinations as used are best suited to produce improved effect throughout the entire frequency range that is possible to produce by the engine through its make and break mechanism.

While in describing the invention, I have referred in detail to the form, arrangement and construction of the various parts thereof, the same is to be considered only in its illustrative sense, so that I do not wish to be limited thereto except as may be specifically pointed out in the appended claims.

I claim as my invention:

1. The combination of an engine starting motor circuit and a source of energy therefor, a magnetic switch in said circuit for controlling the same, a control circuit for said switch including a relay, a transformer including a primary winding and a secondary winding, with the primary winding arranged in circuit with said source of energy and with the secondary winding arranged in said control circuit, an ignition system for said engine including a coil having a primary and a secondary winding, the primary winding of said coil being in circuit with the primary winding of the transformer, means for interrupting the supply of energy to both of said primary windings to induce a current in their associated secondary windings, the secondary winding of the transformer when thus energized operating to actuate said relay in the control circuit to open the motor circuit, and a current value step-up device arranged in circuit with the primary winding of the transformer for causing a phase angle difference in said winding and a higher induced voltage in the secondary winding of the ignition coil for increasing the current value of its output.

2. The combination of an engine starting motor circuit and a source of energy therefor, a magnetic switch in said circuit for controlling the same, a control circuit for said switch including an electrical device, a transformer including a primary winding and a secondary winding, with the primary winding arranged in circuit with said source of energy and with the secondary winding arranged in said control circuit, an ignition system for said engine including a coil having a primary and a secondary winding, the primary winding of said coil being in parallel with the primary

winding of the transformer, means for interrupting the supply of energy to both of said primary windings to induce a current in their associated secondary windings, the secondary winding of the transformer when thus energized operating to actuate said device in the control circuit to open the motor circuit, and a choke coil arranged in circuit with the primary winding of the transformer for causing a phase angle difference in said winding and a higher induced voltage in the secondary winding of the ignition coil for increasing the current value of its output.

3. The combination of an engine starting motor circuit and a source of energy therefor, a magnetic switch in said circuit for controlling the same, a control circuit for said switch including an electrical device, a transformer including a primary winding and a secondary winding, with the primary winding arranged in circuit with said source of energy and with the secondary winding arranged in said control circuit, an ignition system for said engine including a coil having a primary and a secondary winding, the primary winding of said coil being in parallel with the primary winding of the transformer, means for interrupting the supply of energy to both of said primary windings to induce a current in their associated secondary windings, the secondary winding of the transformer when thus energized operating to actuate said device in the control circuit to open the motor circuit, a second electrical device arranged in circuit with the primary winding of the transformer for causing a phase angle difference in said winding and a higher induced voltage in the secondary winding of the ignition coil, and a third electrical device arranged in circuit with the secondary winding of the transformer and with the first mentioned device respectively and operating to deliver an induced current which is reverse to that of the secondary winding of the transformer so as to induce a current flow in the primary winding of the transformer in the direction of the flow of energy therethrough and which current flow is in parallel with the primary winding of the ignition coil to react upon the secondary winding thereof to further increase the current value of its output.

4. The combination of an engine starting motor circuit and a source of energy therefor, a magnetic switch in said circuit for controlling the same, a control circuit for said switch including an electrical device, a transformer including a primary winding and a secondary winding, with the primary winding arranged in circuit with said source of energy and with the secondary winding arranged in said control circuit, an ignition system for said engine including a coil having a primary and a secondary winding, the primary winding of said coil being in parallel with the primary winding of the transformer, means for interrupting the supply of energy to both of said primary windings to induce a current in their associated secondary windings, the secondary winding of the transformer when thus energized operating to actuate said device in the control circuit to open the motor circuit, a choke coil arranged in circuit with the primary winding of the transformer for causing a phase angle difference in said winding and a higher induced voltage in the secondary winding of the ignition coil, and a second choke coil arranged in circuit with the secondary winding of the transformer and with the first mentioned device respectively and operating to deliver an induced current substantially in phase with the ignition coil primary current resulting in an increased secondary output of said coil.

5. The combination of an engine starting motor circuit and a source of energy therefor, a magnetic switch in said circuit for controlling the same, a control circuit for said switch including an electrical device, a transformer including a primary winding and a secondary winding, with the primary winding arranged in circuit with said source of energy and with the secondary winding arranged in said control circuit, an ignition system for said engine including a coil having a primary and a secondary winding, the primary winding of said coil being in parallel with the primary winding of the transformer, means for interrupting the supply of energy to both of said primary windings to induce a current in their associated secondary windings, the secondary winding of the transformer when thus energized operating to actuate said device in the control circuit to open the motor circuit, a choke coil arranged in circuit with the primary winding of the transformer for causing a phase angle difference in said winding and a higher induced voltage in the secondary winding of the ignition coil, and a second choke coil arranged in circuit with the secondary winding of the transformer and with the first mentioned device respectively and operating to deliver an induced current which is reversed to that of the secondary winding of the transformer so as to induce a current flow in the transformer in the direction of the flow of energy therethrough and which current flow is in parallel with the primary winding of the ignition coil to react upon the secondary winding thereof, to further increase the value of its output, said choke coils each including a winding, with the turn ratio of the winding of one choke coil being different from that of the winding of the other choke coil.

6. The combination of an engine starting motor circuit and a source of energy therefor, a magnetic switch in said circuit for controlling the same, a control circuit for said magnetic switch, a relay in said control circuit including a substantially balanced, pivoted member, normally disposed in a position closing said control circuit, said relay further including an armature connected to said member and a coil associated therewith and energizable by a current value corresponding to a predetermined high engine speed to cause said armature to actuate said substantially balanced, pivoted member to open said control circuit and thus cause said switch to break the motor circuit and stop the motor.

7. The combination of an engine starting motor circuit and a source of energy therefor, a magnetic switch in said circuit for controlling the same, a control circuit for said magnetic switch, a relay in said control circuit including a substantially balanced, pivoted member, normally disposed in a position closing said control circuit, said relay further including an armature connected to said member, and a coil associated therewith and energizable by a current value corresponding to a predetermined high engine speed, said coil when energized causing said armature to actuate said pivoted member to open said control circuit and thus cause said switch to break the motor circuit and stop the motor, and means associated with said member and operable when said current value drops to one corresponding to a predetermined low engine

speed for actuating said member to close said control circuit to again cause said switch to close the motor circuit and start the motor.

8. The combination of an engine starting motor circuit and a source of energy therefor, a magnetic switch in said circuit for controlling the same, a control circuit for said magnetic switch, a relay in said control circuit including a substantially balanced, pivoted member, normally disposed in a position closing said control circuit, said relay further including an armature connected to said member and a coil associated therewith and energizable by a current value corresponding to a predetermined high engine speed to cause said armature to actuate said pivoted member to open said control circuit and thus cause said switch to break the motor circuit and stop the motor, and means associated with said member and operable when said current value drops to one corresponding to a predetermined low engine speed for actuating said member to close said control circuit to again cause said switch to close the motor circuit and start the motor, said means being adjustable so as to operate automatically at a current value corresponding to any one of a number of different low engine speeds.

9. In combination with a starting motor circuit and a source of direct current therefor, a transformer in circuit with said source of direct current, a magnetic switch in said circuit for controlling the same, a control circuit for said magnetic switch, a relay in said control circuit including a substantially balanced pivoted member normally disposed in a position closing said control circuit, said relay further including an armature connected to said member and a coil energizable by an alternating current, means for making and breaking said transformer circuit in accordance with engine speed to provide said alternating current which at one value, corresponding to one engine speed energizes said coil to attract the armature to actuate the member to break the control circuit and means operating at an alternating current value corresponding to less than a predetermined low engine speed to cause said member to again close said control circuit.

10. The combination of an engine starting motor circuit and a source of energy therefor, a magnetic switch in said circuit for controlling the same, a control circuit for said switch, a relay associated with the control circuit and including a coil and an armature, a substantially balanced, pivoted member operatively connected to the armature and normally disposed in a position closing the control circuit and engine driven means for controlling the energization of said coil to actuate said balanced pivoted member through the armature to open the magnetic switch circuit.

11. The combination of an engine starting motor circuit and a source of energy therefor, a magnetic switch in said circuit for controlling the same, a control circuit for said switch, a relay associated with the control circuit and including a coil and an armature, a substantially balanced, pivoted member operatively connected to the armature and normally disposed in a position closing the control circuit, a transformer including a primary winding and a secondary winding with the former in circuit with said source of energy and with the latter in circuit with said coil, and engine driven ignition timing means for controlling the energization of said coil from said secondary winding by interrupting the flow of energy to said primary winding.

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