June 4, 1935. L. K. LOEHR ET AL 2,004,053

AUTOMATIC STARTING MECHANISM

Filed Jan. 23, 1931 2 Sheets-Sheet 1

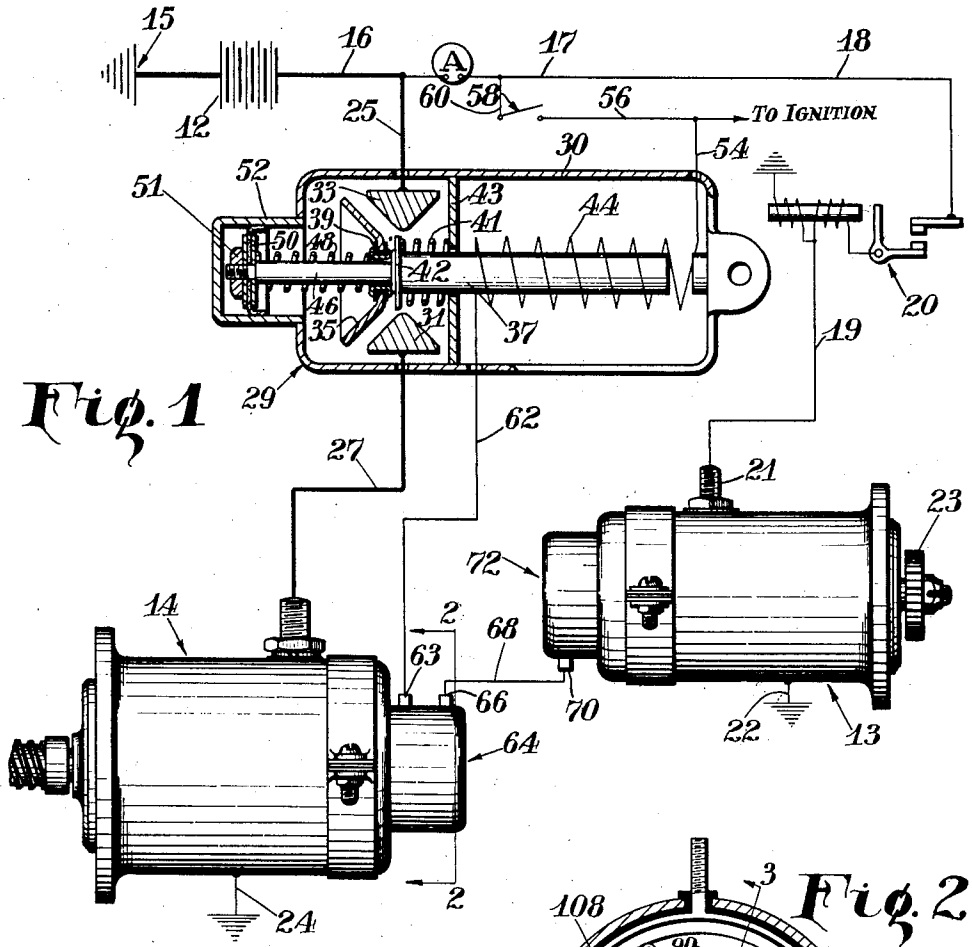


Fig. 1

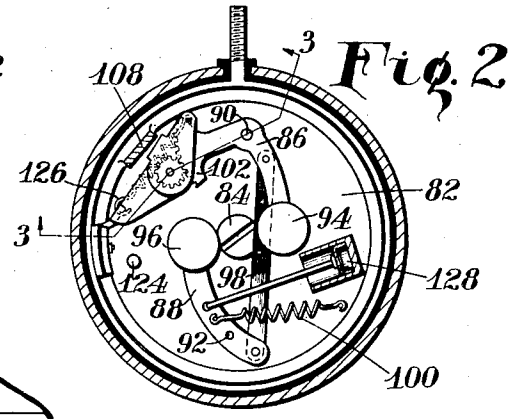


Fig. 2

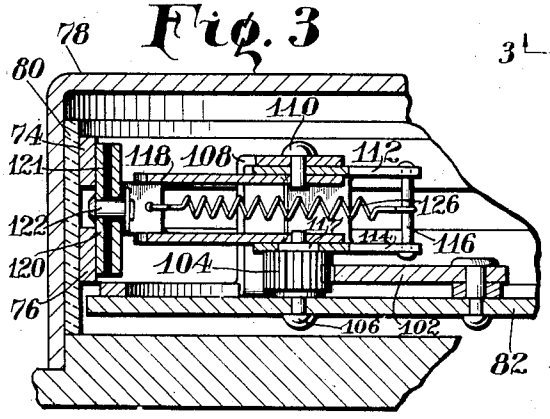


Fig. 3

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Fig. 7

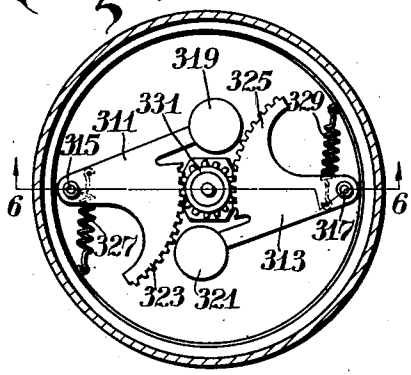


Fig. 6

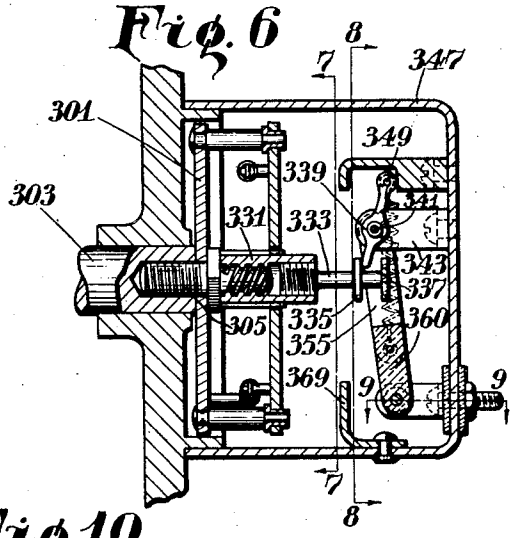


Fig. 10

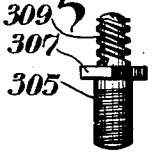


Fig. 9

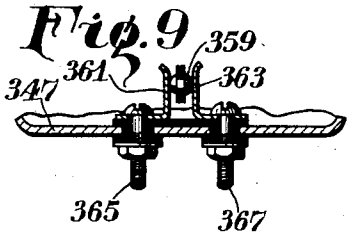


Fig. 8

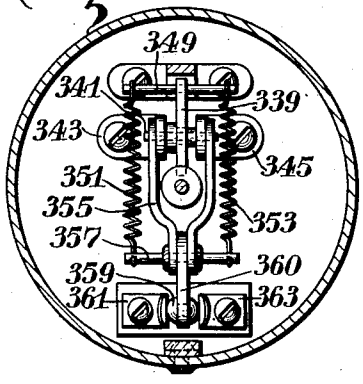


Fig. 4

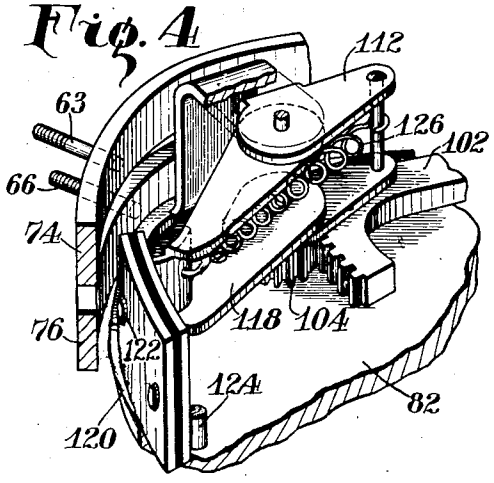
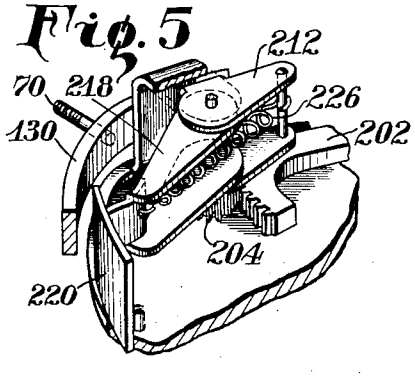


Fig. 5



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AUTOMATIC STARTING MECHANISM

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Application January 23, 1931, Serial No. 510,632

20 Claims. (Cl. 290—36)

This invention relates to automatic starting systems for internal combustion engines and more particularly to improvements in automatic electrical starting systems.

Electrical systems have heretofore been devised for controlling the starting mechanism of internal combustion engines whereby closure of a manual switch such as the ignition switch of the engine will cause the starting mechanism to crank the engine, and to automatically restart the engine in case it should stall. These systems have in general relied on electrical or fluid pressure effects of the rotation of the engine or its auxiliaries to render the starting mechanism inoperative while the engine is running.

An object of the present invention is to provide a novel, automatic starting system which is highly efficient and reliable in operation and of comparatively simple and economical construction.

Another object is to provide such a device including mechanical means for the automatic control of the starting mechanism.

A further object of the invention is to provide such a device which is controlled mechanically both by an element driven by the engine and an element driven by the starting motor.

Another object is to provide such a device in which the starting motor circuit is caused to be interrupted by governor mechanism driven from the starting motor, and in which said circuit is maintained open by a governor device driven from the engine.

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

Fig. 1 shows schematically a preferred form of the present invention;

Fig. 2 is an enlarged sectional view of the governor mechanism driven by the starting motor taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is an enlarged sectional detail taken substantially on the line 3—3 of Fig. 2;

Fig. 4 is an enlarged detail in perspective showing the motor controlled governor switch and part of its actuating mechanism;

Fig. 5 is a similar view on a somewhat reduced scale of the governor switch controlled by the generator;

Fig. 6 is a longitudinal sectional view of another form of governor switch mechanism taken substantially on the line 6—6 of Fig. 7;

Fig. 7 is a sectional view of the same taken on the line 7—7 of Fig. 6;

Fig. 8 is a sectional view of the same substantially on the line 8—8 of Fig. 6;

Fig. 9 is a sectional detail of the switch contact members taken on the line 9—9 of Fig 6; and

Fig. 10 is a detail of the operating screw member for the governor switch mechanism illustrated in Fig. 6.

In Fig. 1 of the drawings, an electrical system for internal combustion engines is illustrated comprising a battery 12, generator 13, and starting motor 14. One terminal of the battery is grounded as indicated at 15 and the other terminal is connected by means of leads 16, 17, 18 and 19 through ammeter A and automatic cut-out 20 to one terminal 21 of the generator 13. The generator is grounded as indicated at 22 and is adapted to be driven by means of a gear wheel 23 from the internal combustion engine, not shown, whereby operation of the engine serves to maintain the battery charged.

The starting motor 14 which is grounded as indicated at 24 is adapted to be energized from the battery 12 by means of a circuit including leads 16, 25 and 27 and an automatic starting switch indicated generally by numeral 29. The automatic starting switch comprises stationary contact members 31 and 33 and a movable bridging contact 35 mounted on an operating member in the form of a sliding plunger 37, insulated therefrom as indicated at 39 and adapted when in engagement with the stationary contact members to close the starting circuit to the motor 14.

Plunger 37 which is of suitable magnetic material is yieldably maintained in a position to open the starting circuit by suitable means such as a spring 41 bearing against an abutment 42 on said plunger and a partition member 43 of switch casing 30. Magnetic actuating means in the form of a solenoid 44 is provided to move the plunger to the right in Fig. 1 to close the starting circuit.

The movable contact member 35 is slidably mounted on a reduced portion 46 of the plunger 37 and is yieldably maintained against the abutment 42 of said plunger as by means of a spring 48 bearing at one end against the member 35 and at the other end against an abutment 50. The abutment 50 is suitably fixed to the reduced portion 46 of the plunger 37 as by means of a nut 51 and, if desired, may be constructed as shown in the form of an obturator slidably mounted in a closed cylindrical extension 52 of the switch casing 30 and forming therewith a dash pot which

retards the movement of the plunger 37 in a direction to close the starting switch.

One terminal of solenoid 44 is connected by means of leads 54 and 56 to a manually operated controlling means in the form of a switch 58 which is preferably the ignition switch of the engine, and which is connected by a lead 60 to the battery lead 17. The other terminal of solenoid 44 is connected by a lead 62 to one terminal 63 of a mechanically operated controlling means responsive to the speed of rotation of the starting motor, in the form of a governor switch mechanism indicated generally at 64 driven from the starting motor shaft. The other terminal 66 of said governor mechanism 64 is connected by a lead 68 to a terminal 70 of a second mechanically operated controlling means in the form of a governor switch mechanism 72 suitably arranged to be responsive to rotational speed of the engine as by being driven by the generator 13. The governor switch mechanisms 64 and 72 comprise centrifugally operated switches placed in series in the circuit of solenoid 44 and so arranged that said centrifugal switches are opened at suitable rotative speeds assumed by the starting motor and the generator respectively when the engine becomes self-operative.

It will be noted that since the three controlling switches, namely the manual switch 58, the motor governor switch 64 and the generator governor switch 72, are all arranged in series in the circuit of the starting switch solenoid 44, said three switches jointly control the operation of the starting switch, and all three must be closed in order to effect the closure of the starting switch.

A preferred form of the governor switch mechanism mounted on the starting motor is illustrated in Figs. 2, 3, and 4 of the drawings. As there illustrated, terminals 63 and 66 are connected to slip rings 74 and 76 rigidly mounted in a casing 78 and insulated therefrom as by means of an insulating sleeve 80 (Fig. 3).

A circular plate 82 is mounted on the end of the motor shaft to rotate therewith as by means of a cap screw 84, Fig. 2, and carries a centrifugal governor device illustrated as comprising a pair of levers 86 and 88 eccentrically pivoted thereon at 90 and 92 and provided with weights 94 and 96 arranged to move outwardly under the action of centrifugal force. The levers are connected for simultaneous motion by means of a link 98 and the outward movement of the weights 94 and 96 is yieldably opposed by suitable means such as a spring 100. The arm 86 is formed as a bell crank lever, one arm of which terminates in a segmental rack 102 adapted to mesh with a pinion 104 freely pivoted on the plate 82 as by means of a pin 106. A bracket 108 fixed rigidly to the periphery of the plate 82 is formed to extend over the pin 106, suitably spaced therefrom and carries pin 110 arranged in alignment with the pin 106. A yoke member comprising parallel arms 112 and 114 and a cross pin 116 is journaled on the pins 106 and 110, the arm 114 being provided with a squared opening adapted to engage with a squared hub 117 on the pinion 104 so that the yoke member is constrained to rotate with said pinion. A switch arm 118 is arranged to be journaled on pins 106 and 110 between the arms 112 and 114 of the yoke member and carries at its outer end a bridging contact member 120 insulated therefrom as indicated at 121, and suitably fixed thereto as by means of rivets 122.

Contact member 120 is adapted to swing into and out of contact with the slip rings 74 and 76, its inward swinging movement being limited by a pin 124 mounted in the plate 82. The position of switch member 118 is controlled by means of a spring 126 which is attached at one end to the outer end of said switch member and at its other end to the pin 116 of the yoke member so that the switch member and yoke form a toggle mechanism and the switch arm 118 is moved with a snap action whenever the yoke is swung sufficiently to cause the spring to pass the dead center position.

If desired, means may be employed to retard the closing action of switch member 118 for a predetermined interval after the starting motor has slowed down below the critical speed. Such retarding means is illustrated in the form of a dash pot 128 mounted on plate 82 and connected to the swinging arm 88 for that purpose. It will be understood that this dash pot performs an analogous function to the dash pot formed by the obturator 50 and either such device may be omitted or the two may be used in conjunction, in which case their effect is cumulative.

The generator operated governor switch 72 as illustrated in Fig. 5 is in general similar to the motor operated switch just described except that in the generator switch there is but a single slip ring 130 connected to the terminal 70 and the switch member 218 is provided with a contact shoe 220 which is grounded on said switch member whereby when the contact 220 engages the slip ring 130 the latter is grounded to the frame of the generator and thence to the ground connection 22. It will be understood that a dash pot such as 128 may be used in the generator governor switch if so desired. The remaining parts of the generator switch correspond with the parts of the motor switch which are numbered analogously thereto and a specific description thereof is therefore believed to be unnecessary.

The operation of the device as above described is as follows:

When the parts are in their normal positions of rest, closure of the ignition switch 58 by the operator completes a circuit from the battery through leads 16, 17, 60, 56, 54, solenoid 44 and the lead 62 to the motor governor switch 64. Since the motor is at rest, bridging contact 120 is in engagement with slip rings 74 and 76 so that the circuit is completed through said governor switch and lead 68 to the generator governor switch 72. Since the generator is also at rest, contact 220 is in engagement with the slip ring 130 so that the circuit is completed to the ground and the solenoid 44 is energized to draw the starting switch member 35 into engagement with contacts 31 and 33 causing the actuation of the starting motor 14 to turn over the engine. The governor switches 64 and 72 are so set that the rotation of the starting motor and the generator during the cranking of the engine is insufficient to cause the governor switches to open, and the cranking therefore continues until the engine starts. When the engine starts, the starting motor is instantly accelerated to high speed which causes the motor governor switch 64 to operate to open the contact 120, breaking the circuit through the solenoid 44 and thus allowing the starting switch member 35 to open. As soon as the engine picks up, and before the starting motor has slowed down, the generator governor switch 72 will be operated by the rota-

tion of the generator to open the contact 220 which will remain open as long as the engine is self-operative.

Upon opening of the starting motor switch, the motor will come to rest and the motor governor switch 64 closes, but the solenoid 44 is prevented from operation by the generator governor switch 72 while the engine is running.

Should the engine stop for any reason, the rotation of the generator ceases and the generator governor switch 72 is caused to close. Thereupon the solenoid 44 operates the starting switch member 35 and the starting operation is repeated.

It will be noted that due to the arrangement of the parts and the reversal of the effects of the springs 126 and 226 on switch members 118 and 218, the governor switches will remain open at considerably lower rotative speeds than are required to initially open said switches. This is advantageous in conjunction with the use of the dash pots 50, 52 or 128 in obviating the possibility of too early action of the switches either in opening or closing.

Another form of governor switch is illustrated in Figs. 6 to 10 inclusive of the drawings. In this form of the invention, a circular plate 301 is rigidly mounted on the end of a driving shaft 303 which may be the starting motor shaft, by means of a cap screw 305 (Fig. 10) having a head 307 for clamping said plate to the shaft, and a coarsely threaded axial extension 309.

The plate 301 carries a pair of governor members 311 and 313 pivoted thereon as by means of pins 315 and 317 and provided with weights 319, 321 and segmental racks 323 and 325. The governor members 311 and 313 are normally retained in their inner positions by yielding means such as springs 327 and 329.

The segmental racks 323 and 325 are adapted to mesh with a pinion member 331 which is internally threaded as shown in Fig. 6 to engage the coarsely threaded extension 309 of the cap screw 305 so that rotation of the pinion by outward movement of the segmental racks will cause longitudinal motion of the pinion to the right in Fig. 6. A switch operating member 333 is rigidly mounted in the outer end of said pinion member 331 and is provided with shoulders 335 and 337 adapted to engage the free end of a lever 339 which is pivotally mounted on a pin 341 supported by a pair of brackets 343 and 345 (Fig. 8) fixed to the casing 347 of the governor switch. The opposite end of the lever 339 carries a pin 349 on which are mounted a pair of springs 351 and 353.

A switch arm 355 formed as a yoke to straddle the switch actuating member 333 is also pivoted on said pin 341 and carries near its other end a cross pin 357 to which the opposite ends of springs 351 and 353 are attached. The outer end of switch arm 355 is provided with a contact member in the form of a double headed rivet 359 insulated from said arm as by being carried by an insulating strip 369 rigidly carried by said arm and adapted to contact with two fixed switch members 361 and 363.

If the governor switch is to be mounted on the starting motor, both the switch members 361 and 363 are insulated from the governor switch casing 347 as illustrated in Fig. 9 and are provided with terminals 365 and 367 for connection similar to terminals 63 and 66 shown in Fig. 1. If the switch is to be used as the generator governor switch only one terminal such as 365 is required, and the insulation of the opposite contact such as 363 is omitted so that said contact is grounded on the generator frame.

It will be understood that a dash pot may be provided in this type of governor switch to retard the closing action thereof if so desired but an illustration thereof is deemed unnecessary.

In the operation of this form of governor switch, rotation of the driving shaft 303 above a critical minimum speed will cause the weights 319 and 321 to move outwardly by centrifugal force against the action of springs 327 and 329, thus causing the rotation of pinion 331 on the screw threads 309 in a direction to move said pinion longitudinally to the right in Fig. 6. The shoulder 335 on the switch actuating member 333 is thus caused to swing the lever 339 in a counterclockwise direction whereby the springs 351 and 353 are caused to snap the switch arm 355 into its open position against the stop member 369. When the rotation of shaft 303 falls below a predetermined minimum, the reverse action takes place and the switch arm 355 is snapped into closed position.

It will be noted that in this embodiment of the invention the effective leverage of the springs 327 and 329 decreases as the weights 319 and 321 move outwardly since the axes of said springs approach the lines drawn through the anchorages of said springs and the pivots 315 and 317 respectively. By this arrangement much less force is required to hold the weights in their outward position than to move them into such position so that as pointed out in connection with the embodiment of the invention first described, the governor switch will remain open at a much lower speed of rotation than that required to open said switch.

Although certain embodiments have been illustrated and described in detail, it will be understood that these embodiments are not exclusive and that various changes may be made in the proportions and arrangements of the parts without departure from the spirit of the invention.

Reference will therefore be had to the claims appended hereto to define the scope of the invention.

What is claimed is:

1. Automatic starting mechanism for internal combustion engines including a starting motor, a switch for controlling said motor, operating means for said switch, and manual means and mechanical means for jointly controlling said operating means, said mechanical means being responsive to the rotational speed of the starting motor.

2. Automatic starting mechanism for internal combustion engines including a starting motor, a switch for controlling said motor, operating means for said switch, and manual means and mechanical means for rendering said operating means inoperative, said mechanical means being responsive to the rotational speed of said engine and of the starting motor.

3. In an electrical system for internal combustion engines, an automatic starting mechanism including an electrical starting motor, a switch adapted to control the operation of said motor, electrical means for operating said starting switch, and mechanical speed responsive means driven from said motor for controlling said operating means.

4. In an electrical system for internal combustion engines, an automatic starting mechanism including an electrical starting motor, a switch adapted to control the operation of said motor, electrical means for operating said starting switch, mechanical speed responsive mechanism driven from said engine, and similar mechanism

driven from said motor, said mechanisms being adapted to jointly control said operating means.

5. In an electrical system for internal combustion engines, an automatic starting mechanism including a starting motor, a magnetic switch for controlling said motor, an electrical circuit including a manual ignition switch and a mechanically operated switch for jointly controlling said magnetic switch, and a centrifugal governor device driven from the starting motor for operating said mechanical switch to maintain the control circuit open as long as the motor is operating above a predetermined speed.

6. In an electrical system for internal combustion engines, an automatic starting mechanism including a starting motor, a magnetic switch for controlling the starting motor and an operating circuit for said magnetic switch including a switch mounted on the generator and a switch mounted on the motor, said switches being adapted to jointly control said operating circuit, means to maintain said generator switch open as long as the generator is rotating above a predetermined speed, and means to maintain the motor switch open as long as the motor is rotating above a predetermined speed.

7. In an electrical system for internal combustion engines, an automatic starting mechanism including a starting motor, a magnetic switch for controlling the starting motor and an operating circuit for said magnetic switch including a switch mounted on the generator and a switch mounted on the motor, said switches being adapted to jointly control said operating circuit, a centrifugal governor device driven from the generator adapted when rotated above a predetermined speed to maintain the generator switch open, and a centrifugal governor device driven from the starting motor adapted when rotated above a predetermined speed to maintain the motor switch open.

8. In an electrical system for internal combustion engines, an automatic starting mechanism including a starting motor, a magnetic switch for controlling the starting motor and an operating circuit for said magnetic switch including a pair of switches for controlling said operating circuit, a centrifugal governor device driven from the generator for controlling one of said switches, and a centrifugal governor device driven from the starting motor for controlling the other said switch, both said governor devices being adapted to open their switches at a predetermined speed above the rotative speed of the parts during the cranking operation, and to close the switches at a predetermined substantially lower speed.

9. In an electrical system for internal combustion engines, an automatic starting mechanism including an electrical starting motor, a magnetic switch for controlling said motor, an electrical control circuit including a manual ignition switch and a mechanically operated switch jointly controlling said magnetic switch, and means for operating said mechanical switch from said starting motor whereby said control circuit is maintained open during the deceleration period of said starting motor, and means associated with said mechanical switch to delay its closing until a predetermined time after the said starting motor has come substantially to rest.

10. Automatic starting mechanism for internal combustion engines including a starting motor, a switch for controlling said motor, operating means for said switch, and mechanical means responsive to the rotational speed of the motor for controlling said operating means including means cooperating to cause closure of said switch when the motor stops and for causing opening of said switch when the motor spins freely.

11. Automatic starting mechanism for internal combustion engines including a starting motor, a switch for controlling said motor, operating means for said switch, means for controlling said operating means including mechanical means responsive to the rotational speed of the engine for energizing the motor in case of engine stall, and mechanical means responsive to the rotational speed of the motor for deenergizing the motor when it spins freely.

12. Control apparatus for internal combustion engines, comprising a current source, a starting motor, a generator, and means for controlling the operation of the starting motor, said controlling means comprising a main switch for controlling the connection of the starting motor with said current source and a plurality of secondary switches controlling the action of said main switch, one of said switches being controlled by the speed of the engine and another of said switches being controlled by the speed of the starting motor.

13. Control apparatus for internal combustion engines, comprising a current source, a starting motor, a generator, and means for controlling the operation of the starting motor, said controlling means comprising a main switch for controlling the connection of the starting motor with said current source and a plurality of centrifugal secondary switches controlling the action of said main switch, one of said centrifugal switches being controlled by the engine, and the other of said centrifugal switches being controlled by the speed of the starting motor.

14. Control apparatus for internal combustion engines, comprising a current source, a starting motor, a generator, and means for controlling the operation of the starting motor, said controlling means comprising a main switch for controlling the connection of the starting motor with said current source and a plurality of centrifugal secondary switches controlling the action of said main switch, one of said centrifugal switches being operated by the generator shaft and the other of said centrifugal switches being operated by the shaft of the starting motor.

15. Control apparatus for internal combustion engines, comprising a current source, a starting motor, a generator, and means for controlling the operation of the starting motor, said controlling means comprising a main switch for controlling the connection of the starting motor with said current source, and a plurality of speed responsive secondary switches for controlling the action of the main switch, one of said secondary switches being operative in response to the speed of the generator shaft, and the other of said secondary switches being operative in response to the speed of the shaft of the starting motor.

16. Control apparatus for internal combustion engines, comprising a current source, a starting motor, a generator, and means for controlling the operation of the starting motor, said controlling means comprising a magnetic switch controlling the circuit between the current source and said starting motor, and a plurality of automatically operated mechanical switches controlling the action of said magnetic switch, one of said mechanical switches being operable in response

to the speed of the engine and another of said switches being operable by the starting motor itself.

17. Control apparatus for internal combustion engines, comprising a current source, a starting motor, a generator, and means for controlling the operation of the starting motor, said controlling means comprising a magnetic switch controlling the circuit between the current source and said starting motor, and a plurality of automatically operated mechanical switches controlling the action of said magnetic switch, one of said mechanical switches being driven by the generator shaft and another of said switches being driven by the shaft of the starting motor.

18. Control apparatus for internal combustion engines comprising a starting motor therefor, a current source, a generator, and means for controlling the operation of said starting motor, said controlling means including a plurality of centrifugal switches operable by the engine and the starting motor respectively to render the starting motor inoperative, said centrifugal switches being so constructed that a greater speed of the engine and starting motor is necessary to effect opening of said switches than to subsequently maintain the switches open.

19. Control apparatus for internal combustion engines comprising a starting motor therefor, a current source, a generator, and means for controlling the operation of said starting motor, said controlling means including a magnetic switch controlling the starting motor and a plurality of automatic mechanically operated switches for controlling the action of said automatic switch, one of said mechanically operated switches being controlled solely by the speed of the engine and another of said mechanically operated switches being controlled solely by the speed of the starting motor.

20. Control apparatus for internal combustion engines comprising a starting motor, a driving pinion adapted to be automatically moved by the starting motor into driving engagement with a part of the engine to be driven thereby whenever the starting motor is operative, a current source, a switch for closing the circuit between the starting motor and the current source to render the starting motor operative, a plurality of switches for controlling the operation of said last named switch, one of said plurality of switches being controlled by the engine and the other of said switches being controlled by the starting motor itself.

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