

June 18, 1940.

J. B. DYER

2,205,375

CONTROL APPARATUS FOR ENGINE STARTERS

Original Filed Sept. 23, 1933

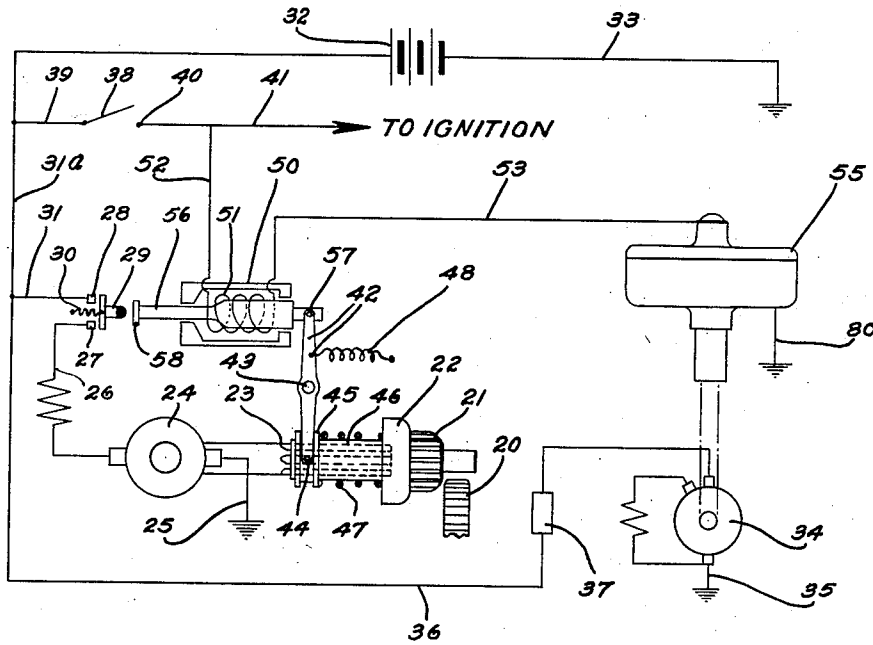


Fig. 1

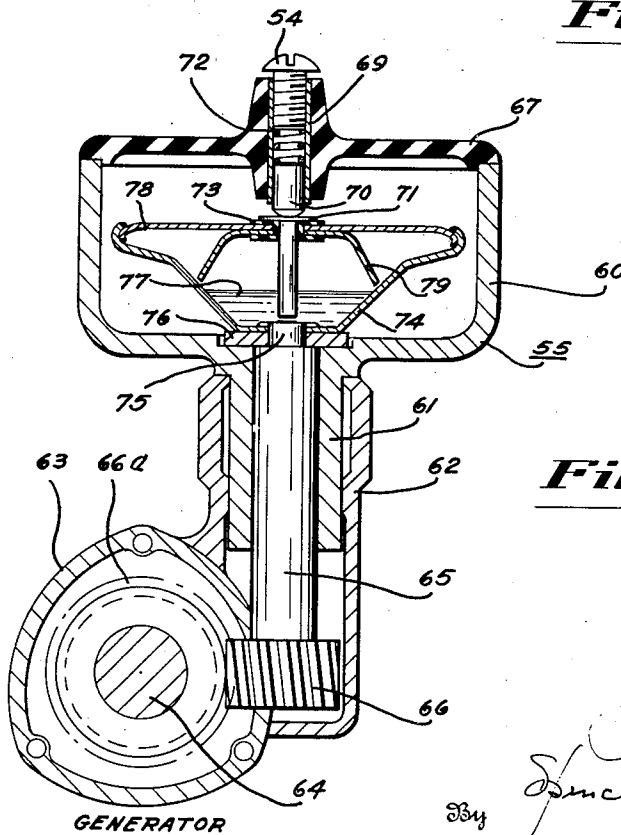


Fig. 2

GENERATOR

By

Inventor
John B. Dyer
Sincer Hardman & Fehr
Attorney

UNITED STATES PATENT OFFICE

2,205,375

CONTROL APPARATUS FOR ENGINE
STARTERS

John B. Dyer, Dayton, Ohio, assignor to General
Motors Corporation, Detroit, Mich., a corpora-
tion of Delaware

Original application September 23, 1933, Serial
No. 690,652. Divided and this application De-
cember 18, 1936, Serial No. 116,638

6 Claims. (Cl. 200—80)

This invention relates to control apparatus for engine starting devices and more particularly to starting devices of the automatic type which are rendered operative by the ignition switch or some other of the various engine control devices and rendered inoperative automatically upon operation of the engine under its own power.

It is the general purpose of this invention to provide a control apparatus for engine starting devices of this character having improved means for rendering the starting device inoperative when the engine begins to run under its own power, which is so constructed that the starting device is never rendered inoperative during cranking of the engine by the starting device, but is maintained in an inoperative condition as long as the engine continues to run, so that it is impossible to cause operation of the starting device when the engine is in motion, however slow such motion may be.

More specifically, it is an object of the invention to provide in apparatus of the character referred to an automatic control switch of centrifugal type operable by a moving part of the engine and so designed that it cannot be opened until the engine is operating at a speed higher than cranking speed; that having once been opened cannot be closed until the engine has come to a complete stop and the closing action of which is always delayed for an appreciable interval after the engine has stopped.

A further object of the invention is to provide a switch of centrifugal type so designed that a higher speed of rotation is required to open said switch than to hold it open, and having means to delay the closing of such switch, said means operating independently of the speed of rotation of the switch. While the switch disclosed is particularly useful in a starter control system such as illustrated in this application, it will be understood that its use is not limited to this particular relation but the switch is capable of general application wherever it is desired to control a circuit in the manner effected by the switch disclosed.

The above objects are accomplished according to the present invention by the provision of a magnetic switch for closing the starting motor circuit, the operation of which is controlled by a centrifugal switch driven by the generator shaft. The centrifugal switch is of the mercury type, is normally closed and is so designed that relatively rapid rotation of the centrifugal switch is necessary to move the mercury to position to open

the switch while the mercury is held in position to maintain the switch open until the centrifugal switch comes substantially to a stop. In addition, means is provided to delay the return of the mercury to switch closing position after the rotation of the switch has ceased.

This application is a division of application Serial No. 690,652.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

Fig. 1 is a wiring diagram disclosing a preferred form of the present invention.

Fig. 2 is an enlarged sectional view of the control switch forming part of the present invention.

In the diagram the engine is represented by a flywheel gear 20 adapted to be engaged by a pinion 21 connected by a one-way roller clutch 22 with a longitudinally splined shaft 23, driven by an electric starting motor 24, which is grounded by the connection 25 and connected by a wire 26 with one fixed contact 27 of a main switch which controls the starting motor circuit. The switch comprises a second fixed contact 28 and a movable contact 29 which is adapted to be moved into position to engage both fixed contacts by means hereinafter described and is normally held in open position by a spring 30. The fixed contact 28 is connected by wires 31 and 31a with a storage battery 32, grounded by the connection 33. A generator 34 is grounded through the connection 35 and is connected by a wire 36 with the wire 31, the usual cut-out relay 37 being provided, as shown in Fig. 1.

The ignition apparatus of the engine is not illustrated herein but it will be understood that it is connected with the generator 34 or the battery 32 by an ignition switch which has a movable contact 38 connected by wire 39 with the wire 31 and a fixed contact 40 which is adapted to be engaged by the contact 38 and is connected by the wire 41 with the ignition system of the engine.

It will be clear that the circuit of the starting motor is completed when the movable contact 29 is moved into engagement with the fixed contacts 27 and 28, and at such time current will flow from the battery through the wires 31 and 31a, contacts 28, 29 and 27 and wire 26 to the starting motor, through the connection 25 to ground and from ground through the wire 33 back to the battery.

As stated above, the movable contact 29 is normally disengaged from the fixed contacts 27 and 28 and the pinion 21 is also normally out of engagement with the flywheel gear as shown in Fig. 1. The movable contact is moved to closed position and the pinion 21 is moved into engagement with the flywheel gear so that the operation of the starting motor will crank the engine by means which will now be described. To this end a lever 42 is provided, which is suitably pivoted at 43 and the lower end of which is provided with pins 44 which engage a grooved collar 45 slidable on a sleeve 46 which is secured to or integral with one member of the roller clutch 22, a spring 47 being received on the sleeve between the grooved collar and the clutch.

The lever 42 is normally held in the position shown in the drawing by a spring 48 and when the lever is rocked in a counterclockwise direction, it is effective to move the pinion 21 to its gear engaging position. If during this movement of the lever the teeth of the pinion and the gear abut the spring 47 is compressed until the movable contact is moved to switch closing position by means later described, when the starting motor will rotate the shaft 23 until the teeth of the pinion and flywheel are in proper meshing position at which time the spring 47 will force the pinion into proper engagement with the gear. In case the teeth of the pinion and gear do not abut the pinion will be moved directly into engagement with the gear before the switch is closed.

The lever 42 is operated by means of an electromagnet 50 having a winding 51 which is connected at one end by a wire 52 to the wire 41 which leads from the fixed contact of the ignition switch to the ignition system of the engine and at the other end by the wire 53 which is connected to a binding post 54 on an automatic control switch indicated in its entirety by the reference character 55 and hereinafter described in detail. The electromagnet is also provided with an armature in the form of a rod 56 which is pivotally connected at 57 with the lever 42 and at its opposite end is provided with an enlarged head 58 which is adapted to engage the movable switch contact 29 to move said contact to its switch closing position as the lever 42 is rocked in a counterclockwise direction, which takes place whenever the electromagnet is energized. When the magnet is de-energized the combined action of the springs 47 and 48 move the lever 42 in a clockwise direction to effect opening of the starting motor switch and to demesh the driving pinion 21 from the gear 20. The energization of the electromagnet is controlled by the ignition switch and by the switch 55 which will now be described.

As will be clear from Fig. 2, the switch 55 is a switch of the centrifugal type and comprises a cup-shaped member 60 which has a downwardly depending portion 61 which is secured in any desirable way in an outer sleeve 62 which extends upwardly from a housing 63 surrounding the generator shaft which is indicated at 64. The inner sleeve 61 serves as a journal for a shaft 65 to which is secured at its lower end a gear 66 adapted to mesh with a suitable worm-gear indicated in dotted lines at 66a which is secured to the generator shaft and rotatable therewith. A cover plate 67 is secured in any desirable way to the cup-shaped member 60, said cover plate being formed of suitable insulating material. The binding post 54 is screwed into a sleeve 69

which is secured in position in the cover plate 67 and slidable within such sleeve is a pin 70 adapted to engage a contact member 71, being held in engagement with the member 71 by a spring 72 which is received between the pin 70 and the binding post 54. The contact member 71 extends through a suitably flanged bushing 73 formed of insulating material and projects downwardly into the lower part of a cup-shaped sheet metal shell 74, which is secured to the shaft 65, said shaft having a reduced portion 75 which projects through an opening in the shell 74 and through a suitable bushing 76, the end of said reduced portion being riveted over the edge of the opening in shell 74 to hold the entire assembly together, or secured to the shell in any other desirable way. The lower part of the cup-shaped member 74 is adapted to be partially filled with mercury indicated at 77 and a cover plate 78 is welded at its periphery to the upper edge of the cup-shaped member 74 to prevent any possible leakage of mercury from the chamber formed between the member 74 and the cover plate. The bushing of insulating material 73 extends through a suitable opening in the cover plate and also through an inverted cup-shaped sheet metal member 79 which, with the cover plate, is received between the flanges of the bushing of insulating material and the lower edge extends to a point very close to the surface of the cup-shaped member 74 so as to provide a very narrow passage of annular form between members 74 and 79. The cup-shaped element 68 is grounded by the connection 80 as shown in the drawing.

Obviously, when the mercury is in the bottom of the member 74, as shown in the drawing, contact is made between the pin 71 and the member 74 which is metalically connected to the grounded member 60, but when the shaft 65 is rotated at relatively high speed, the mercury will be forced to move outwardly by centrifugal force and will gradually move up the surface of the cup-shaped member 74 until it assumes a position in the upper part of the chamber formed between the members 74 and 78 and outside of the inverted cup-shaped member 79 so as to break the connection between the pin 71 and the grounded portion of the switch.

It will be noted that the lower portion of the member 74 is inclined at a greater angle from the horizontal than is the upper portion thereof. The purpose of this is to make it necessary to rotate the shaft 65 more rapidly in order to cause the mercury to move up the slope of the lower portion of the cup-shaped member than is necessary to hold the mercury in that portion of the chamber between the members 74 and 78, which is above the point where the angle of the member 74 is decreased, while the engine is running. It will be clear that after the mercury is moved into this portion of the chamber that portion of the member 74 upon which the mercury rests is at a very slight angle from the horizontal so that a relatively low speed rotation of the shaft 65 will be sufficient to hold the mercury in that part of the chamber and the shaft will have to come substantially to a complete stop before the mercury can return to the lower part of the member 74 where it normally is positioned when the engine is not running.

The purpose of the inverted member 79 is to delay the return of the mercury to switch closing position after the switch has almost been opened irrespective of the speed of rotation of the device

during engine operation. The member 19 forms a narrow passage for the mercury to flow through and in its return to switch closing position so that the flow of mercury therethrough must take an appreciable time when the shaft 65 is fully stationary. The reason this is done is to prevent any possibility of the switch being reclosed after it has once been opened before the shaft of the starting motor, itself, has come to rest. Otherwise, it might be possible for the engine to be started, to stop almost immediately thereafter, and the switch would be reclosed before the starting motor, itself, had stopped, in which event the teeth of the pinion or flywheel gear might be broken because the closing of the switch would cause the action of the electromagnet and a movement of the pinion toward meshing position while some of the parts were still in motion.

When the control switch 55 is closed, as shown in Fig. 2 and the ignition switch is also closed, current will flow from the battery through wires 31a, 39, the ignition switch, wires 41 and 52, winding 51 and wire 53 to the switch 55, thence through the binding post 54, pin 70, contact member 71 and the mercury in the bottom of the member 74 to said member and thence through the ground connection 80 to ground and also through the ground connection 33 from ground back to the battery. It will be clear, therefore, that when the ignition switch is closed when the engine is not running, the magnet 50 will be immediately energized to close the starting motor circuit and operate the lever 42, but as soon as the generator is operated at sufficient speed when the engine begins to operate under its own power, the mercury in the switch 55 will be so moved by centrifugal force as to open the circuit of the magnet which will result in the stopping of the starting motor and the demeshing of the pinion 21 from the flywheel gear. If for any reason the engine should stop running while the ignition switch is closed, it will be automatically restarted without any attention on the part of the operator as soon as the mercury can flow back into the bottom of the member 74 to close the circuit between the contact member 71 and said member 74, which flow will take a sufficient amount of time to insure that the starting motor shaft will always be at rest when the control switch is closed.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In control apparatus for engine starting devices having an electric starting motor and a starter switch for causing the motor to become operative, a centrifugal control switch operable by the engine for controlling the operation of said starter switch, said control switch comprising a chamber adapted to contain mercury and having a sump in which the mercury is received when the engine is at rest, a cup-shaped wall extending upwardly and outwardly from said sump and a cover plate cooperating with said wall to form the chamber, said cup-shaped wall having two portions arranged at different degrees of inclination to the horizontal, whereby different speeds of rotation will cause the mercury to flow outwardly over the two portions of the wall.

2. In control apparatus for engine starting devices having an electric starting motor and a starter switch for causing the motor to become

operative, a vertical shaft rotatable by a shaft driven by the engine, a cup-shaped wall supported on said vertical shaft, a cover plate cooperating with said wall to form a chamber adapted to contain mercury, the mercury being in the bottom of said chamber when the engine is at rest and being caused to flow outwardly on said cup-shaped wall when said chamber is rotated upon operation of the engine under its own power, a contact projecting into the mercury when the engine is at rest so as to close the circuit through the control switch, said circuit being broken by the outward flow of mercury upon rotation of said chamber and said cup-shaped wall being so constructed that the bottom part of said wall lies at a greater angle to the horizontal than does the upper part of said wall.

3. A centrifugal control switch comprising a rotatable chamber adapted to contain mercury and having a sump in which the mercury is received when the chamber is at rest, a cup-shaped wall extending upwardly and outwardly from said sump and a cover plate cooperating with said wall to form the chamber, said cup-shaped wall having portions arranged at different degrees of inclination to the horizontal such that said mercury is caused to flow outwardly on the surface of said wall to open the control switch when the chamber is rotated at a higher speed than is necessary to retain the mercury in the outer part of said chamber and such that the mercury is retained in the outer part of said chamber at a lower speed than is necessary to cause the mercury to flow to the outer part of the chamber, and a baffle plate adjacent said wall to form a restricted passage between itself and the wall, so as to delay the return of the mercury to the sump upon stopping of the rotation of said chamber.

4. A centrifugal control switch comprising a rotatable chamber adapted to contain mercury and having a sump in which the mercury is received when the chamber is at rest, a cup-shaped wall extending upwardly and outwardly from said sump and a cover plate cooperating with said wall to form the chamber, said cup-shaped wall being so constructed that its angle of inclination to the horizontal is greater near the sump than near the outer edge of the wall, said mercury being caused to flow outwardly on the surface of said wall to open the control switch when the chamber is rotated, and a baffle plate supported by said cover plate and extending to a point adjacent said wall to form a restricted passage between itself and the wall so as to delay the return of the mercury to the sump upon stopping of the rotation of said chamber.

5. In control apparatus for engine starting devices having an electric starting motor and a starter switch for causing the motor to become operative and a control circuit for controlling the operation of said starter switch, a centrifugal control switch operable by the engine for opening and closing said control circuit, said control switch comprising a chamber mounted for rotation on a vertical axis and having a sump in which mercury is received when the engine is at rest to effect closing of the control circuit, said chamber having a wall extending upwardly and outwardly from said sump, whereby the mercury is caused to flow outwardly along said wall when the said chamber is rotated, and being so constructed that higher speed rotation of the chamber is necessary to cause a flow of mercury from said sump to open said control circuit than is

necessary to maintain the mercury in its switch open position and prevent the return of the mercury to the sump.

5 6. In control apparatus for engine starting devices having an electric starting motor and a starter switch for causing the motor to become operative and a control circuit for controlling the operation of said starter switch, a centrifugal control switch operable by the engine for
10 opening and closing said control circuit, said control switch comprising a chamber mounted for rotation on a vertical axis and having a sump in which mercury is received when the engine is at rest, contacts spaced apart, but adapted to be

closed by the mercury received in said sump in order to close the control circuit, a wall extending outwardly and upwardly from the sump and means for rotating said chamber when the engine is in operation, whereby the mercury is
5 caused to flow outwardly along said wall to break the circuit between said contacts, said wall being so shaped that a greater speed of rotation of said chamber is necessary to cause the mercury to
10 flow from said sump to effect opening of the switch than is necessary to keep the mercury in the position to which it has been moved by the rotation of said chamber.

JOHN B. DYER.