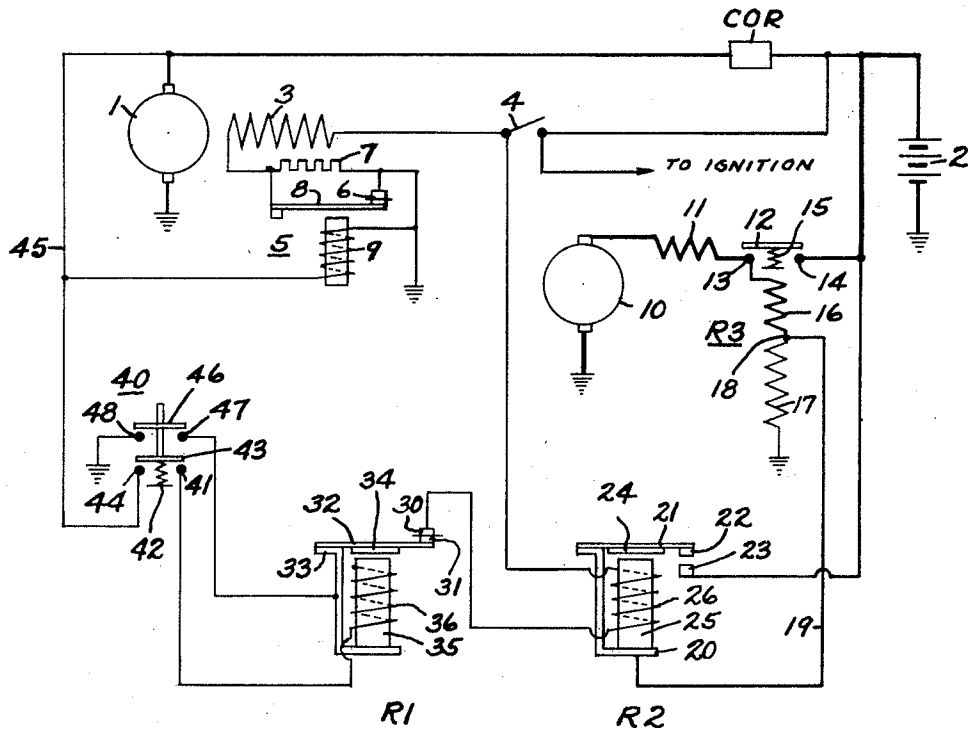
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ENGINE STARTING APPARATUS WITH GENERATOR SEPARATELY EXCITED DURING STARTING

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ENGINE STARTING APPARATUS WITH GENERATOR SEPARATELY EXCITED DURING STARTING

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This invention relates to the control of the engine starter of vehicle propelling internal combustion engines, particularly an engine which idles at very low speed.

An object of the present invention is to prevent inadvertent operation of the engine cranking electric motor while the engine is self-operative and particularly while the engine is running at a very low idling speed. This object is accomplished by an electrical system which includes a generator driven at variable speed by the vehicle propelling engine. Instead of using a wholly self-excited generator as has been the practice heretofore in automotive electrical systems, the generator of the present system has a shunt field winding which is separately excited by the storage battery until the generator attains a voltage sufficient for battery charging; and the present system includes apparatus which becomes effective to prevent use of the engine cranking motor when the generator voltage attains a value intermediate between the value at maximum engine cranking speed and the value at minimum engine idling speed. In the disclosed embodiment of the invention this apparatus includes a relay switch having a magnet coil which is connected with the generator terminals when the motor controlling switch is closed, said relay switch being constructed to operate when generator voltage is above the value attained at maximum cranking speed and below the value attained at minimum engine idling speed. For example, in a system for charging a six-volt storage battery, if the generator voltage attained at maximum cranking speed is about 2 volts and the generator voltage attained at minimum engine idling speed is about 4.5 volts, the relay switch would be constructed to operate at about 3.2 volts. Separate excitation of the generator field before the generator is connected with the storage battery by a cut-out relay enables the generator to produce, at maximum engine cranking speed and minimum engine idling speed, voltages such that their differential is a substantial amount as contrasted with the very low differential for a self-excited generator whose voltage rise in same low speed range is very gradual since that rise is initiated solely by residual magnetism. The substantial voltage differential which the separately excited generator provides in the low speed range enables the use of apparatus which can be relied upon not to interfere with the engine starting operation and to prevent inadvertent use of the engine starter while the engine is running even at low idling speed.

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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.

The figure of the drawing is a wire diagram of the present invention.

Referring to the drawing, a generator 1 is connectible through a reverse current or cut-out relay COR with a battery 2. Generator 1 has a shunt field winding 3 which is separately excited from the battery 2 by closure of the ignition switch 4. Shunt field current is controlled by voltage regulator 5 having normally closed contacts 6 by-passing a resistance 7 connecting one end of the winding 3 with ground. Separation of contacts 6 is under control by magnet coil 9 responsive to a generator voltage which the regulator is set to control. When geenrator voltage exceeds a certain value, an armature 8 is attracted to separate the contacts 6 whereupon resistance 7 becomes effective to reduce generator field current.

The engine is started by operation of a starting motor 10 having a series field winding 11 connectible with battery 2 by engagement of a contact 12 with contacts 13 and 14 of a relay R3. Contact 12 is maintained spaced from contacts 13 and 14 by a spring 15 and contact 12 is moved into engagement with contacts 13 and 14 in the response to energization of relays magnet coils 16 and 17. Coil 16 has relatively few turns of relatively coarse wire and coil 17 has a relatively large number of turns of relatively fine wire.

The junction 18 of coils 16 and 17 is connected by wire 19 with a frame 20 of a relay R2. Frame 20 supports and is electrically connected with a leaf spring 21 carrying a contact 22 normally separated from a contact 23 connected with the battery 2. The leaf spring 21 supports an armature 24 facing a core 25 surrounded by a winding 26, one end of which is connected with the battery 2 when ignition switch 4 is closed. The other end of coil 26 is connected with a contact 30 normally engaged by a contact 31 of a relay R1. Contact 31 is carried by a leaf spring 32 supported by and electrically connected with a frame 33 of a relay R1. Leaf spring 32 supports an armature 34 facing a magnet core 35 attached to the frame 33, the core is surrounded by a magnet coil 36, one end of which is attached to core 35 and, hence, is electrically connected with frame 33. The other end of coil 36 is connected with a switch contact 41 of a manually operated normally open switch 40. By closing switch 40 against the action of a

spring 42, a contact 43 connects contact 41 with a contact 44 connected with a wire 45 which connects regulator coil 9 with the non-grounded terminal of generator 1. Switch 40 has normally opened contact 46 which, when closed, bridges contacts 47 and 48 to connect frame 33 of relay R1 with ground.

To start the engine a driver closes ignition switch 4 and switch 40. The following circuit is established: battery 2, ignition switch 4, coil 26 of relay R2, normally closed contacts 30 and 31, spring blade 32, frame 33, of relay R1 and switch contact 46 engaging contacts 47 and 48. Coil 26 having been energized, contact 22 engages contact 23 of relay R2 and the following circuit is established: battery 2, contacts 23 and 22, spring blade 21, frame 20, wire 19, coil 17 of relay R3 to ground, coil 16, switch contact 13, field coil 11, and starting motor 10 to ground. The motor 10 operates to crank the engine. When the engine becomes self-operative and while its speed is less than that required to cause the generator to develop a voltage sufficient to cause the cutout relay COR to connect it with the battery and even before the generator attains a minimum idle speed, the speed of the generator will be such as to cause it to develop a voltage such that coil 36 of relay R1 will be energized sufficiently to separate contact 31 from contact 30 and coil 26 of relay R2 will be deenergized and contact 22 will separate from contact 23 to open circuit coils 16 and 17 of relay R3 thereby causing switch contact 12 to be opened by a spring 18. The starting motor 10 will cease operating regardless of failure of the driver to release switch 40 as soon as the engine became self-operative. The operation of the engine starting motor 10 cannot be effected while the engine is running even at low idle speed. Closure of the switch 40 under those conditions will not cause operation of the starting motor 10 because relay R1 would immediately separate its contact 31 from contact 30 because the voltage of generator 1 would then be in excess of that required for sufficient energization of relay coil 36 to separate contact 31 from contact 30 before the engine had attained minimum idle speed. Relay R1 is set to open its contacts when the voltage of the generator is between the value at maximum engine cranking speed, for example 2 volts, and the value at the lowest engine idling speed, for example 4.5 volts. The relay is set to open its contacts preferably about 3.2 volts.

If it should happen that the generator is not functioning to produce the required minimum voltage to open the contact of relay R1, discontinuance of the starting operation can be effected by opening switch 40. When the starting operation is not discontinued automatically, the driver will know that the generator is not functioning properly and will drive to a service garage where the generator can be put in proper condition.

The armature shaft of the starting motor 10 can be connected with the engine flywheel gear by a pinion which is automatically shifted by virtue of rotation of the armature shaft or the starting motor may be connected with the flywheel gear by a pinion which is shifted by movement of an armature effected by energization of coils 16 and 17 of relay R3, the retraction of the magnetically shifted pinion being effected by a spring when coils 16 and 17 are deenergized, as disclosed more fully in the patent of John B. Dyer, 2,302,687, issued November 24, 1942.

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.

What is claimed is as follows:

1. An electrical system for automotive vehicles comprising an engine driven generator; a storage battery; a cut-out relay for connecting the generator with the battery when the generator attains a voltage sufficient for battery charging, said generator having a shunt field winding; an electric motor for cranking the engine; a plurality of manually operated switches for controlling operation of the motor; a circuit including one of the switches for connecting the field winding directly with the battery whereby the generator is separately excited until the generator voltage exceeds battery voltage; and means for preventing operation of the starting motor while the engine is self operative when all of the switches are closed, said means including all of the switches and normally closed contacts of a relay, said relay having a coil; and a circuit established by closure of all of the switches for connecting the relay magnet coil with the generator, said relay being responsive to separate its contacts when the generator voltages attain a certain value.

2. An electrical system for automotive vehicles comprising an engine driven generator; a storage battery; a cut-out relay for connecting the generator with the battery when the generator attains a voltage sufficient for battery charging, said generator having a shunt field winding; an electric motor for cranking the engine; a manually operated ignition switch and a pair of auxiliary switches manually operated by a common actuator for controlling operation of the motor; a circuit including the ignition switch for connecting the field winding directly with the battery whereby the generator is separately excited until generator exceeds battery voltage; means for causing the motor to be connected with the battery and including the ignition switch and the auxiliary switches and normally closed contacts of a relay, said relay having a magnet coil; and a circuit established during the closure of the auxiliary switches for connecting the relay magnet coil with the generator terminals, said relay being responsive to open its contacts when generator voltage attains a certain value, said circuit being open when one of the auxiliary switches is open.

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