

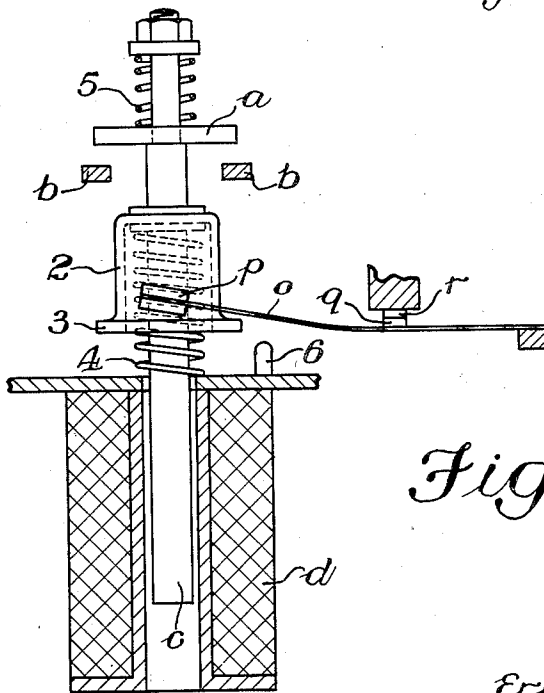
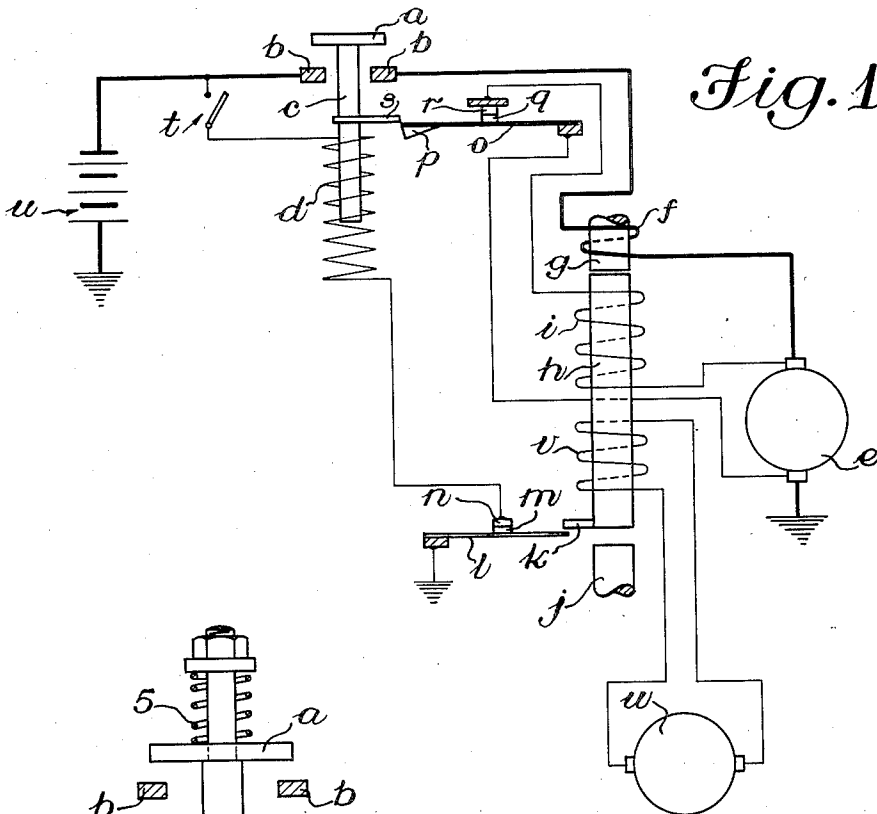
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AUTOMATIC ENGINE STARTING APPARATUS

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AUTOMATIC ENGINE STARTING
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This invention relates to automatic engine starting apparatus for internal combustion engines, particularly those used on motor road vehicles. The kind of apparatus to which the invention relates usually includes means whereby on the closing of a switch an electric starting motor is set in motion, and will thereafter remain under the control of the engine. After the engine has been started by the motor the latter is stopped, but should the engine stop at any time (otherwise than at the will of the driver) the motor will come into action again automatically for restarting the engine.

An already known system comprises a starting motor which operates a pinion mounted on a screw threaded shaft. When the motor is set in motion the pinion first moves along the shaft into engagement with a toothed wheel on the engine, and then imparts motion from the motor to the engine. After the engine has started, the interaction of the said toothed wheel and pinion causes the latter to move out of engagement with the wheel and return to its initial position on the screw threaded shaft. The switch (starting switch) in the circuit of the starting motor is closed by an electromagnet under the control of a hand switch. The closing of the starting switch causes current to flow to the motor from a battery and so sets the motor in action. In the motor circuit are arranged two electromagnet or solenoid windings one of them being in series with the motor and the other in parallel. The series winding serves to magnetize a fixed iron mass whilst the shunt winding serves to magnetize a movable iron mass or plunger. This plunger is also controlled by a "hold on" winding arranged to be energized by a dynamo driven by the engine. The purpose of the plunger is to operate a switch in the circuit of the electromagnet of the starting switch. After the starting switch has been closed, the heavy current flowing to the motor through the series winding aforesaid holds the plunger out of action, the magnetic effect of that winding being for a time stronger than that of the parallel winding. But as the motor speed increases the current supplied to it falls, and the magnetic effect of the series winding weakens, while, owing to the consequent rise in voltage, that of the parallel winding rises. After the engine is started, the motor is thereby allowed to accelerate and the action of the parallel winding overcomes that of the series winding and causes the plunger to move. By this movement the switch in the circuit of the electromagnet of the starting switch is opened,

causing the starting switch to be released and to be opened by a spring. The motor is thus stopped, but owing to the motion of the engine current is generated by the dynamo driven by the engine and part of this current is supplied to the "hold on" winding for the purpose of retaining the plunger in the position to which it was moved, so that the opening of the starter switch has no effect on that plunger. When the engine stops for any reason the "hold on" coil releases the plunger and allows it to return to its initial position under the action of a spring, thereby causing the switch in the circuit of the electromagnet of the starting switch to close. Unless this circuit has been opened by the hand switch, the starting switch at once closes and causes the engine to be restarted automatically, when the above described cycle of operations is repeated.

In a system as above described, a difficulty has been experienced owing to the fact that when the motor is started it accelerates rapidly and may reach a high speed of rotation before the pinion engages the wheel on the engine. Due to the corresponding fall which occurs in the current in the motor circuit, the plunger above mentioned may release the starting switch before the pinion has moved into its active position, and consequently the system may operate to open and reclose the starting switch prior to full engagement of the pinion, thus causing unnecessary delay in initiating the starting operation.

An object of the present invention is to obviate this possibility and to ensure reliable operation of the system.

The invention comprises the combination with the magnet winding which is in parallel with the starting motor circuit, of an interrupter which is controlled directly or indirectly by the starting switch, provision being made for an appropriate delay of action of the interrupter so that the circuit through the said winding is not closed until sufficient time has elapsed to allow the pinion to engage the wheel on the engine.

In particular the invention comprises an interrupter in the form of a vibratory blade carrying a contact which cooperates with a fixed contact, and means associated with the electromagnet of the starting switch for setting the blade in vibration, the arrangement being such that the vibration persists and the proper closing of the circuit containing the blade is delayed for a sufficient time to allow engagement of the pinion with the wheel on the engine.

In the accompanying sheet of explanatory drawings:

Fig. 1 is a diagram illustrating one mode of carrying the invention into effect.

Fig. 2 is a diagram illustrating one method of producing vibratory motion of the interrupter of the aforesaid parallel winding.

Referring to Fig. 1, the starting switch comprises a movable contact *a* arranged to cooperate with fixed contacts *b*. The movable contact is actuated by a plunger *c* associated with a magnet winding *d*. This switch controls the circuit of the engine starting motor *e*, and in this circuit is arranged a winding *f* (usually consisting of a single turn) surrounding an iron pole *g*. With this pole cooperates a plunger *h* which is magnetized by current in a winding *i* arranged in parallel with or as a shunt to the starting motor. At the opposite end of the plunger *h* to the pole *g* is arranged another pole *j*. The plunger *h*, by means of, for example a projection *k* is adapted to open a switch in the winding *d*, which switch comprises a spring blade *l* carrying a contact *m* which can cooperate with a fixed contact *n*.

In the circuit of the winding *i* is arranged a spring blade *o* which can be caused to vibrate and which will persist in a state of vibration for a suitable time, the blade being suitably loaded by a weight *p*. This blade carries a contact *q* which cooperates with a fixed contact *r*. The blade is set in motion by the plunger *c* of the starting switch when the starting switch closes, by suitable means such as the engagement of the free end of the blade by a projection *s* on said plunger.

When the switch *t* of the winding *d* is closed, by hand or otherwise, current flows through the winding from the battery *u*, and causes the starting switch to close. A heavy current now flows through the winding *f* to the starting motor. At first the current through *f* is sufficiently strong to counteract the effect of the current in *i*, and the plunger *h* will be held by pole *g*. But with increase of the speed of the motor, the effect of the current in *i* will tend to increase, and the current through the winding *f* will decrease due to the increasing back E. M. F. of the motor. With the closing of the starting switch *a*, however, the vibratory blade *o* was set in motion by the flick given to it by the part *s* when it passed the end of the blade. So long as this motion persists the current cannot rise as it otherwise would in the winding *i*. But when the blade comes to rest, the current in *i* will reach its normal value, and when the engine starts, this current will cause the plunger *h* to move away from the pole *g* towards the pole *j*. This movement causes the circuit of the winding *d* to be opened through the blade *l*. The effect of the vibratory motion of the blade *o* is to delay the action of the plunger *h* for a sufficient time to ensure the engagement of the starting pinion and the application of the cranking load to the starting motor prior to the energization of the winding *i*.

The interruption of the circuit of the winding *d* allows the starting switch to open under the action of a spring (not shown) and so interrupt the supply of current to the starting motor. To prevent the return of the plunger *h* at this stage under the action of a spring (not shown) the plunger is provided with another winding *v* which is excited by current from dynamo *w* which is driven by the engine. So long as the engine is working the plunger *h* will be held and the switch *l* will remain open. But if the engine stops inadvertently, the plunger *h* will return to

the position shown in the diagram and the engine will be restarted automatically. To put the apparatus out of action it is necessary to reopen the switch *t*.

Referring now to Fig. 2, we show there an alternative means for controlling the switch blade *o*. On the plunger *c* of the starting switch is secured an iron part 2 which is formed with a flange or projection 3 which can engage the iron weight *p* at the free end of the blade *o* and bend the blade upwardly so that the contacts *r*, *q* are held together tightly. The contact *a* is slidable on the plunger *c* and is held on a shoulder on the plunger by a spring 5. The switch is held open by a spring 4. When the magnet *d* is excited the plunger *c* is drawn down for closing the part *a* on to the contacts *b*, carrying the part 2 with it. After the part *a* has been arrested by the parts *b* the part 2 can continue to move (movement of *c* relatively to *a* being 20 permitted by spring 5), and owing to the fact that the part 2 is magnetized by the magnetization of plunger *c*, it drags the weighted end of the blade *o* with it. The contacts *q*, *r* are thereby separated. But before the part 2 reaches the end of its 25 movement the blade *o* is arrested by a non-magnetic striker 6, causing the weight *p* to be separated from the part 2 and also causing the blade *o* to vibrate. This vibration persists for a sufficient time to effect the object already described. When the blade comes to rest the contact pieces *r*, *q* will be in contact and the circuit of the winding *i* will consequently be closed.

The invention is not limited to the example above described and subordinate details of construction or arrangement may be varied to suit different requirements.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In automatic engine starting apparatus a starting circuit including a starting switch, means under the control of the operator for closing the starting switch, means responsive to cranking load for holding the starting switch closed, means for overcoming the holding means and opening the starting switch when the engine starts, and means for delaying the energization of the opening means for a predetermined time.

2. In automatic engine starting apparatus a starting circuit including a starting switch, means under the control of the operator for closing the starting switch, means responsive to cranking load for holding the starting switch closed, means energized by closure of the starting switch for overcoming the holding means and opening the starting switch when the engine starts, and means for delaying the energization of the opening means for a predetermined time after closure of the starting switch.

3. In automatic engine starting apparatus a starting circuit including a starting switch, means under the control of the operator for closing the starting switch, means energized by closure of the starting switch for holding said starting switch closed, means also energized by closure of the starting switch for overcoming the holding means and causing the starting switch to open when the engine starts, and means for delaying energization of the opening means for a predetermined time after closure of the starting switch.

4. In automatic engine starting apparatus a starting circuit including a starting switch, means

under the control of the operator for closing the starting switch, means energized by closure of the starting switch and operative in response to the cranking load to hold said starting switch closed, means also energized by closure of the starting switch for overcoming the holding means and causing the starting switch to open when the cranking load is relieved by the self-operation of the engine, and means for delaying energization of the opening means until after the initiation of the cranking operation.

5. In automatic starting apparatus for internal combustion engines a starting circuit including a magnetic starting switch, a control circuit therefor including make and break mechanism, electromagnetic means energized by closure of the starting switch and responsive to the cranking load on the starting circuit for holding the make and break mechanism closed, electromagnetic means also energized by closure of the starting switch for overcoming the holding means and opening said make and break mechanism when the engine starts, and means for delaying effective energization of the opening means.

6. In automatic starting apparatus for internal combustion engines a starting circuit including a starting motor and a magnetic starting switch, a control circuit therefor including make and break mechanism, electromagnetic means energized by closure of the starting switch and responsive to the cranking load on the starting circuit for holding the make and break mechanism closed, electromagnetic means also energized by closure of the starting switch but in shunt with the starting motor for overcoming the holding means and opening said make and break

mechanism when the engine starts, and means for delaying effective energization of the opening means until after the starting motor has begun to crank the engine.

7. In automatic starting apparatus for internal combustion engines a starting circuit including a magnetic starting switch, a control circuit therefor including a control relay, said relay having a series coil for holding the relay closed during cranking, and a shunt coil for opening the relay when the engine starts, both said coils being controlled by the starting switch, and means actuated by closure of the starting switch for delaying the effective energization of the shunt coil for a predetermined time after closure of the starting switch.

8. In automatic starting mechanism for internal combustion engines a magnetic starting switch, means for closing said switch if the engine stalls, and for opening said switch when the engine starts, and means actuated by closure of the starting switch for preventing energization of said opening means for a predetermined time after closure of the starting switch.

9. In automatic starting mechanism for internal combustion engines a starting circuit including a magnetic starting switch, a control circuit therefor including a control relay, said relay having a coil energized by closure of the starting switch and operative to open the relay, means for controlling said coil including normally closed contacts, and means operated by closure of the starting switch for opening said contacts and preventing effective closure thereof for a predetermined time.

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