Oct. 14, 1952 P. L. SCHNEIDER 2,614,230

ENGINE STARTING APPARATUS

Filed Oct. 28, 1948

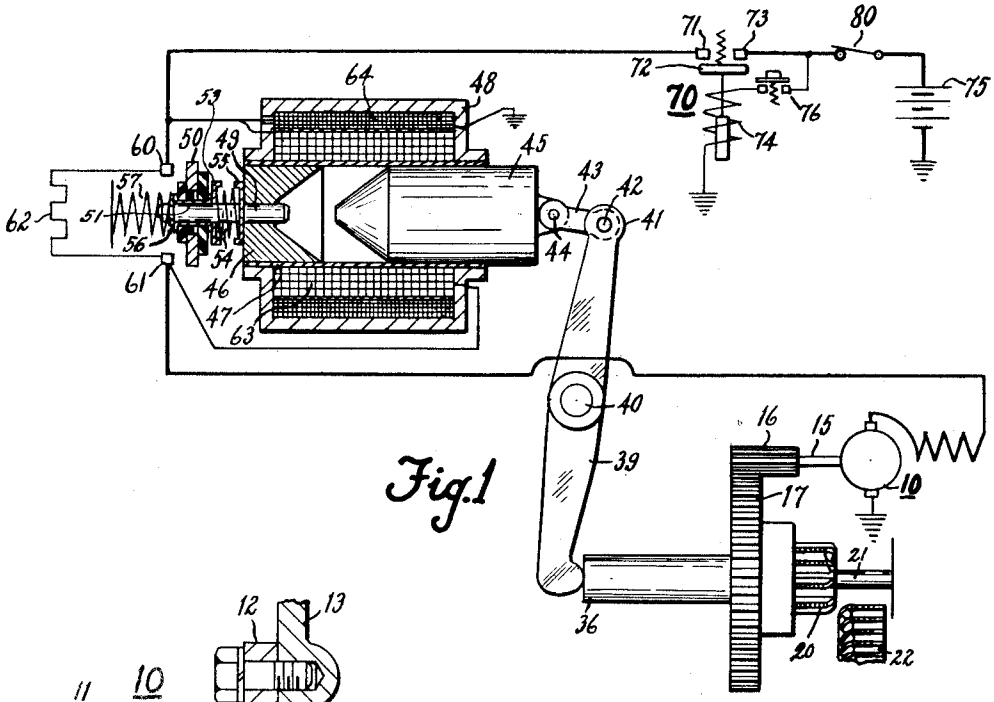

Fig. 1

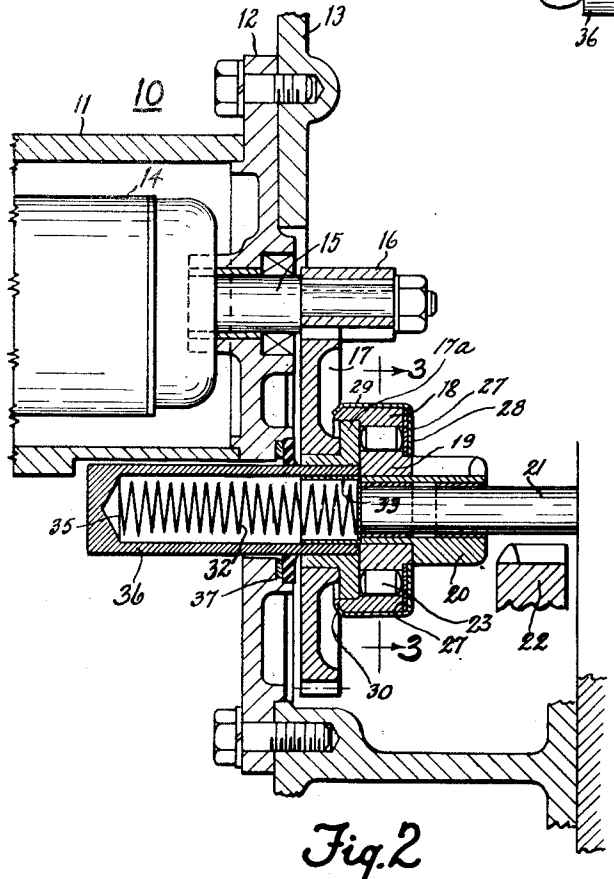

Fig. 2

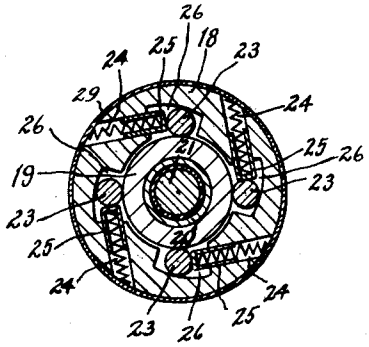

Fig. 3

INVENTOR

PAUL L. SCHNEIDER

BY Spencer Hardman & Fehr

HIS ATTORNEYS

Patented Oct. 14, 1952

2,614,230

UNITED STATES PATENT OFFICE

2,614,230

ENGINE STARTING APPARATUS

Paul L. Schneider, Anderson, Ind., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application October 28, 1948, Serial No. 57,056

4 Claims. (Cl. 290—38)

1

This invention relates to engine starters and its object is to provide slow initial movement of the starting motor pinion to facilitate meshing thereof with the engine flywheel gear and to withhold the application of current for engine starting to the starting motor until after the gears have been completely meshed.

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 diagram illustrating the starter.

Fig. 2 is a fragmentary, longitudinal, sectional view showing a starting motor and gearing for connecting it with the engine flywheel gear.

Fig. 3 is a sectional view on line 3—3 of Fig. 2.

The starting motor 10 (Fig. 2) has a field frame 11 secured to plate 12 which is mounted on a housing 13 provided by the engine. The armature 14 of the motor is connected with an armature shaft 15 connected with a gear 16 meshing with a sliding gear 17 connected through a gear hub 17a with a driving member 18 of a one-way roller clutch having a driven cylinder 19 connected with the pinion 20 which is mounted upon a rod 21 supported by the engine frame and is movable into mesh with the engine flywheel gear 22. When clutch member 18 rotates counterclockwise as viewed in Fig. 3, it becomes connected with the driven member 19 through rollers 23 which springs 24 pressing on plungers 25 urge into the narrower portions of pockets 26 provided by member 18. The rollers 23 are retained by a washer 27 retained by the flange 28 of a shell 29 surrounding member 18 and deformed at 30 against it. Shell 29 serves to retain the springs 24.

The assembly of gear 17 and overrunning clutch is normally maintained in the position shown in Fig. 2 by a spring 32 confined under compression between a cup 33 engaging the rod 21 and surface 35 of a plunger 36 connected with gear hub 17a. Spring 32 maintains the pinion 20 spaced from gear 22 and gear 17. An oil seal 37 minimizes escape of oil from the housing which encloses the gears and the entrance of dirt and moisture therein.

Plunger 36 is engaged by a lever 39 (Fig. 1) pivoted at 40 and having an arm 41 connected by a pin 42 with a link 43 connected by a pin 44 with a solenoid armature 45. Solenoid armature 45 is supported for horizontal sliding movement

2

toward a fixed core 46 by non-magnetizable tube 47 supported by a magnetizable shell 48 which supports the core 46. Armature 45 is engageable with a rod 49 which extends through a sleeve 51 insulatingly supporting a contact 50, a washer 53, a spring 54 and a C-washer 55 received by a groove in rod 49 and retained therein by the spring 54. Spring 54 urges the sleeve 51 toward a split ring 56 snapped into groove of rod 49. A spring 57 which engages the sleeve 51 urges the washer 55 against the core 46 and maintains the contact 50 normally out of engagement with contacts 60 and 61 which are connected with a resistance 62.

Contact 60 is connected with magnet coil 63 of larger wire and magnet coil 64 of finer wire which, respectively, are connected with contact 61 and ground. Contact 60 is connected with contact 71 of the solenoid switch 70 having a movable contact 72 for connecting contact 71 with contact 73 which is connected with a battery 75.

When a switch 76 is closed, coil 74 of solenoid switch 70 is energized and contact 72 connects contacts 71 and 73. Current flows from the battery to winding 64 and ground return to the battery and also through winding 63, starting motor 10 and ground return to the battery and through resistance 62, the starting motor 10 and ground return to the battery. Armature 45 moves left thereby moving the pinion 20 into engagement with the flywheel gear 22. While the pinion 20 is moving toward the gear 22, it is rotating relatively slowly since the resistance 62 and the coil 63 in parallel therewith pass current to the motor 10 sufficient for it to develop a torque which overcomes frictional resistance but not sufficient to rotate the pinion 20 if it abuts the gear 22. If there is no abutment following the first closing of switch 76, the armature 45 continues its left movement to move the pinion 20 into mesh with the gear 22 and to cause the contact 50 to engage contacts 60 and 61 thereby shorting resistance 62 and coil 63 and causing cranking current to be applied to the motor 10. Coil 64 alone will maintain contact 50 in engagement with contacts 60 and 61 against the action of spring 57 (at the left of the contact 50) and spring 32 in the plunger 36.

If gear tooth abutment follows the first closing of switch 76, it is released to allow spring 32 to move the pinion 20 away from the gear 22 and the switch 76 is closed again. The pinion 20 rotates slowly again to a different angular position as it moves toward the gear 22. Generally

a second closure of switch **76** will result in location of the pinion **20** in meshing registration with the gear **22** by the time the pinion has moved into contact with the gear.

Contact **50** does not engage contacts **60** and **61** until after pinion **20** has been substantially fully meshed with gear **22**. Therefore the motor **10** cannot develop cranking torque until after the gears have been meshed. The motor **10** cranks the engine; and, when the engine becomes self-operative, it drives the pinion **20** faster than it can be driven by the motor **10**, and pinion **20** overruns the gear **17** by virtue of the overrunning clutch.

The engine having been started, the switch **76** is released and the solenoid switch **70** opens to disconnect the battery from the motor and the solenoid windings **63**, **64**.

If, after meshing the pinion with the engine gear and moving the contact into engagement with contacts **60** and **61** the engine does not start and the motor **10** is stalled, the switch **76** is opened to effect deenergization of the solenoid so that spring **57** is effective to separate contact **50** from contacts **60** and **61**, said separation being permitted because lever **39** can move clockwise although plunger **36** is fixed. The short circuit of resistance **62** having been interrupted, the torque of motor **10** is so reduced that spring **32** is able to effect retraction of the pinion from the engine gear.

A manually operated switch **80** may be placed in the circuit between the battery **75** and the solenoid switch **70** in order to open the circuit after the engine is running thereby preventing operation of the starter by inadvertent closing of switch **76**.

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. Engine starting apparatus comprising an electric motor, a pinion normally spaced from a gear of the engine to be started and movable into mesh therewith, a spring for retracting the pinion from the engine gear and for yieldingly maintaining it in said spaced relation, an overrunning clutch connecting the motor and pinion, a battery, a solenoid having an armature and a main armature attracting coil and an armature holding coil, means for transmitting motion from the armature to the pinion to cause it to mesh with the engine gear, a circuit between terminals of the battery and including a control switch in series with two circuits in parallel one of which includes the holding coil and the other of which includes the motor and the main coil and a resistance in parallel with the main coil, said resistance and main coil together passing to the motor current sufficient only to cause it to rotate the pinion while out of contact with the engine gear, and a switch which is operated by the solenoid armature to short-circuit the main coil and resistance only after the pinion has been substantially fully meshed with the engine gear.

2. Engine starting apparatus comprising an electric motor, a pinion normally spaced from a gear of the engine to be started and movable into mesh therewith, a spring for retracting the pinion from the engine gear and for yieldingly maintaining it in said spaced relation, an overrunning clutch connecting the motor and pinion, a battery, a solenoid having a plurality of windings and an armature, means for transmitting

motion from the armature to said pinion to move the latter into mesh with the engine gear, a circuit for the starting motor including the battery, a manually closed switch, a resistance and a connection from the resistance to said motor, said resistance having a value such that when current flows through said circuit to the motor the motor develops a torque sufficient only to turn the pinion while it is disengaged from the engine gear, said solenoid windings being connected to said starting motor circuit between the manually operable switch and the resistance whereby the solenoid windings are subject to the full effect of the battery to engage said pinion with the engine gear, a switch operable when the pinion is fully engaged with said gear to short circuit said resistance and to connect the motor directly with said battery, and a connection from one of said windings to said starting motor circuit between said last named switch and the motor whereby one of said windings is short circuited when said last named switch is closed.

3. Engine starting apparatus comprising an electric motor, a pinion normally spaced from a gear of the engine to be started and movable into mesh therewith, a spring for retracting the pinion from the engine gear and for yieldingly maintaining it in said spaced relation, an overrunning clutch connecting the motor and pinion, a battery, a solenoid having a plurality of windings and an armature, means for transmitting motion from the armature to said pinion to move the latter into mesh with the engine gear, a circuit for the starting motor including the battery, a manually closed switch, a resistance and a connection from the resistance to said motor, said resistance having a value such that when current flows through said circuit to the motor the motor develops a torque sufficient only to turn the pinion while it is disengaged from the engine gear, said solenoid windings being connected to said starting motor circuit between the manually operable switch and the resistance whereby the solenoid windings are subject to the full effect of the battery to engage said pinion with the engine gear, a switch operable when the pinion is fully engaged with said gear to short circuit said resistance and to connect the motor directly with said battery, a connection from one of said windings to said starting motor circuit between said last named switch and the motor whereby one of said windings is short circuited when said last named switch is closed, and a connection from the other of said windings to ground whereby said last named winding is rendered effective to hold the pinion in engagement with the gear after the other of said windings is short circuited.

4. Engine starting apparatus comprising an electric motor, a pinion normally spaced from a gear to the engine to be started and movable into mesh therewith, a spring for retracting the pinion from the engine gear and for yieldingly maintaining it in said spaced relation, an overrunning clutch connecting the motor and pinion, a battery, a soleoid having a plurality of windings and an armature, means for transmitting motion from the armature to said pinion to move the latter into mesh with the engine gear, a circuit for the starting motor including the battery, a manually closed switch, a resistance and a connection from the resistance to said motor, said resistance having a value such that when current flows through said circuit to the motor the motor develops a torque sufficient only to

turn the pinion while it is disengaged from the engine gear, said solenoid windings being connected to said starting motor circuit between the manually operable switch and the resistance whereby the solenoid windings are subject to the full effect of the battery to engage said pinion with the engine gear, a switch operable by the magnet armature, when the latter has moved to a position to effect engagement of said pinion with the engine gear, to short circuit said resistance and to connect the motor directly with said battery, and a connection from one of said windings to said starting motor circuit between said last named switch and the motor whereby one of said windings is short circuited when said last named switch is closed.

PAUL L. SCHNEIDER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,290,472	Zimmerman	Jan. 7, 1919
1,305,136	Loomis	May 27, 1919
1,343,028	Bijur	June 8, 1920
1,368,635	Kratz et al.	Feb. 15, 1921
1,414,653	Kratz	May 2, 1922
1,468,430	Whisler et al.	Sept. 18, 1923
1,501,497	Schwarz	July 15, 1924
1,943,182	Louette	Jan. 9, 1934
2,178,098	Elkin	Oct. 31, 1939
2,301,440	Nardone	Nov. 10, 1942