April 6, 1965 A. H. SEILLY 3,177,368

ENGINE STARTING MECHANISM

Filed Feb. 15, 1963 3 Sheets-Sheet 1

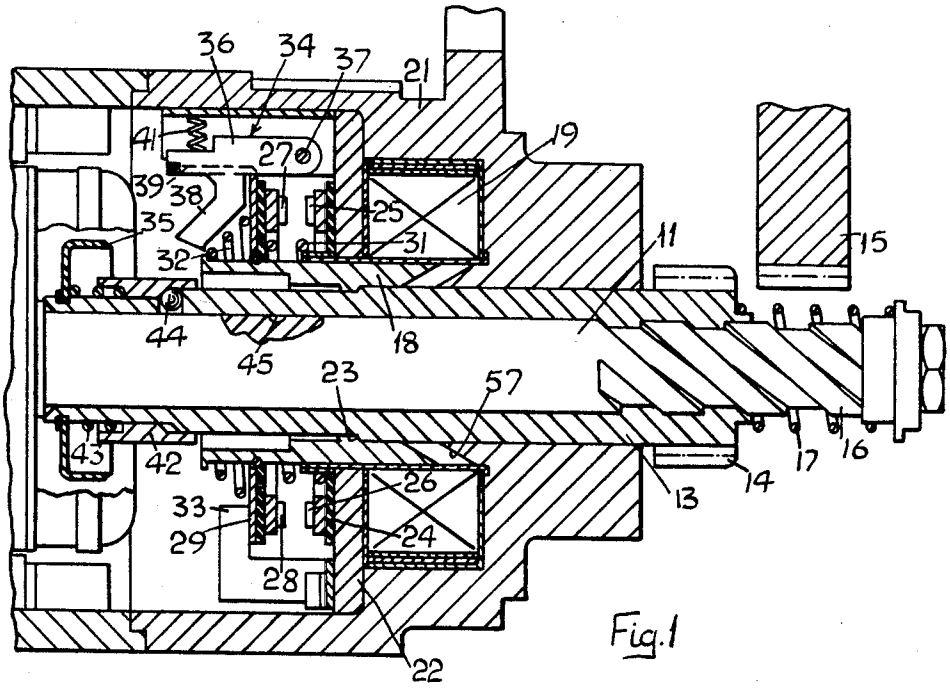

Fig. 1

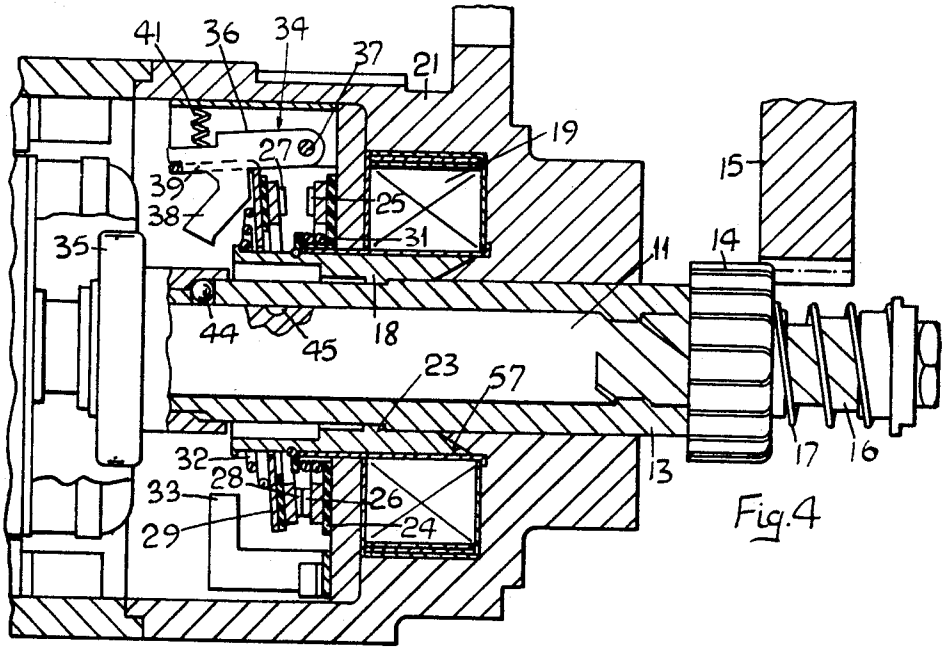

Fig. 4

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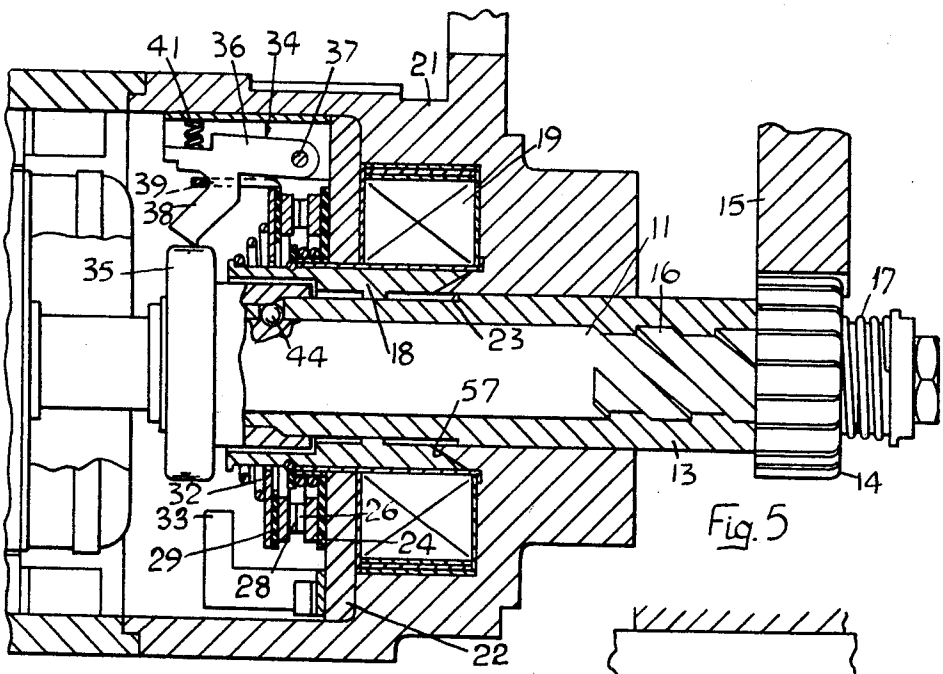

Fig. 5

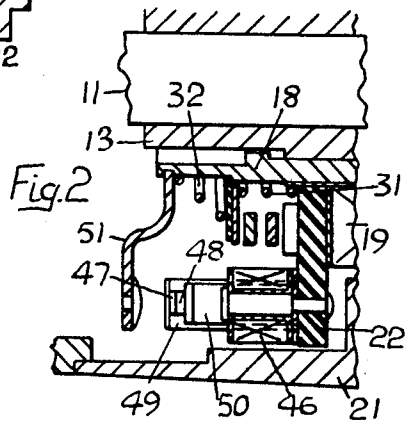

Fig. 2

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ENGINE STARTING MECHANISM

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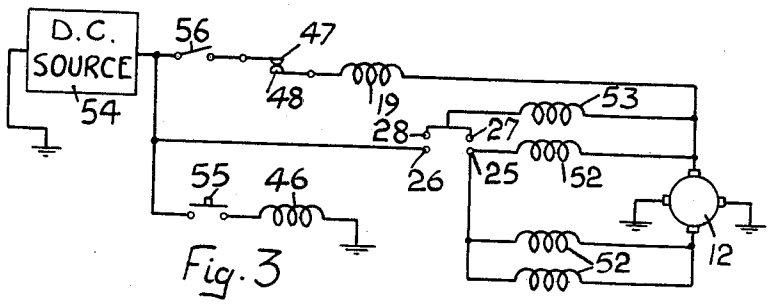

Fig. 3

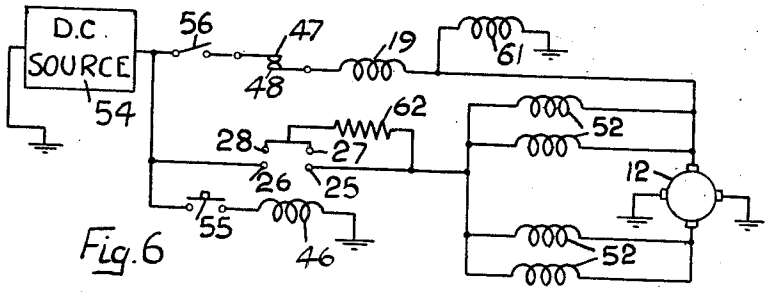

Fig. 6

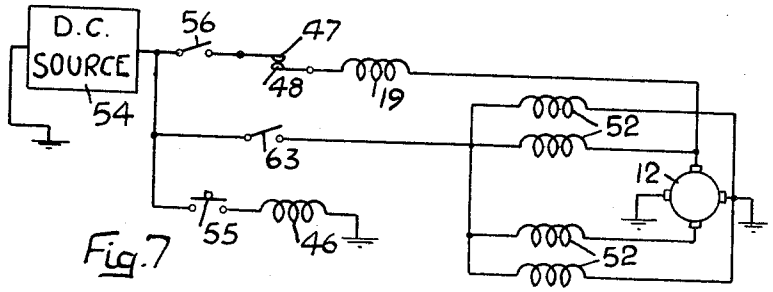

Fig. 7

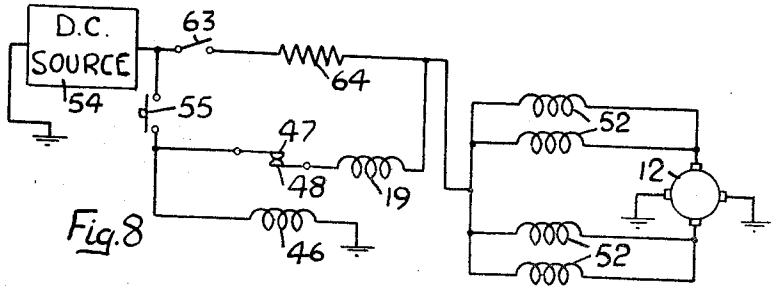

Fig. 8

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ENGINE STARTING MECHANISM

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11 Claims. (Cl. 290—38)

This invention relates to engine starting mechanism of the kind comprising a motor, a pinion rotatable with the armature spindle of the motor, a solenoid for moving the pinion into engagement with a toothed wheel on the engine against the action of resilient means a starter switch for energizing the solenoid, and a motor switch arranged to be closed when the pinion and toothed wheel are in engagement, and thereby complete a circuit to energize the motor, the arrangement being such that when the starter switch is opened the spring will disengage the pinion and toothed wheel.

According to the invention, in starting mechanism of the kind specified the solenoid winding is connected across a part of the circuit in which the current flow is inversely proportional to the speed of the motor, the arrangement being such that, if the starter switch is held closed after the engine has started, when the speed of the motor exceeds a predetermined value the resilient means will overcome the action of the solenoid winding, so that the pinion is withdrawn from engagement with the toothed wheel and the motor switch is opened to break the circuit to the motor.

An example of the invention is illustrated in the accompanying drawings, in which:

FIGURE 1 is a sectional side view of part of an engine starting mechanism,

FIGURE 2 is a fragmentary sectional side view taken in a different plane from FIGURE 1 and illustrating a detail,

FIGURE 3 is a circuit diagram illustrating the electrical connections of the starting mechanism in the rest position,

FIGURES 4 and 5 respectively are views similar to FIGURE 1 but illustrating the mechanism in different positions, and

FIGURES 6 to 8 respectively are modified circuit diagrams.

Referring first to FIGURE 1, an extended end of the armature spindle 11 of the motor armature 12 (FIGURE 3) has mounted on it an axially slidable sleeve 13 made from non-magnetic material. At the end of the sleeve 13 remote from the motor is formed or secured a pinion 14 adapted to engage a toothed wheel 15 on the engine to be started. The spindle 11 and sleeve 13 are interconnected by a quick-pitch screw-thread 16, or an equivalent means such as a pin on the one part engaging a slot on the other part, and the sleeve 13 is urged in a direction to disengage the pinion and toothed wheel by a spring 17.

Axially slidable on the sleeve 13 is a cylindrical solenoid core 18, the winding 19 of the solenoid being mounted in the motor casing 21 and located in position by a magnetic annular plate 22. The sleeve 13 is provided with a circumferential shoulder 23 which abuts against a complementary shoulder on the core 18.

Surrounding the core 18 and abutting against the plate 22 is an annular disc 24 formed from electrically insulating material and carrying the fixed contacts 25, 26 of a pair of switches. The movable contacts 27, 28 of these switches are carried by an annular tiltable disc 29 which surrounds the core 18 and is loaded on opposite directions by springs 31, 32. In its rest position

the disc 29 bears against an arm 33 extending from the plate 22, and is engaged by a pivotal catch 34. A collar 35 is secured to the sleeve 13 for releasing the catch 34 in a manner to be described.

The catch 34 consists of a lever 36 which is pivotally connected to the casing 21 as indicated at 37. Integral with the lever 36 is a tail 38 passing through a slot in a lug 39 extending integrally from the periphery of the disc 29. A spring 41 loads the lever 36 to the position shown in which part of the lever abuts against one end of the slot to hold the disc 29 in the position shown.

Also surrounding the sleeve 13 is a collar 42 which is loaded towards the pinion 14 by a spring 43 and abuts against a ball 44 located in a hole extending through the sleeve 13. The ball 44 is engageable with a recess 45 in the spindle 11 in a manner to be described.

Referring now to the fragmentary view shown in FIGURE 2, the plate 22 supports a relay coil 46. Moreover, spaced from the coil 46 are a pair of closed contacts 47, 48, the plate on which the contact 48 is mounted being formed from magnetic material. The contacts 47, 48 are secured to the plate 22 by a pair of spring blades 49, 50 which extend behind the winding 46 as viewed in FIGURE 2. The blades 49, 50 permit the contacts 47, 48 to be moved into contact with the casing of the relay coil 46 in a manner to be described by an arm 51 carried by the core 18. However, the spacing between the contact 48 and the casing of the coil 46 is such that when the coil 46 is energized the contact 48 is not moved into contact with the relay casing.

The electrical connections of the components described above are illustrated in FIGURE 3, which in addition illustrates the main field windings 52 and auxiliary field winding 53 of the motor, a D.C. source 54 for operating the motor, a starter switch 55 and a normally open contact 56 operable by the relay coil 46.

In operation, the mechanism is operated by closing the switch 55, thereby energizing the relay coil 46. The switch 56 now closes to energize the winding 19, which attracts the core 18. Movement of the core 18 serves through the shoulder 23 to move the sleeve 13 axially to effect an initial engagement of the pinion 14 and toothed wheel 15. The extent of this initial movement is determined by abutment between the core 18 and a shoulder 57 in the casing 21. Moreover, during this movement the upper part of the disc 29 is held by the catch 34, and the spring 32 acting between the core 18 and the disc 29 tilts the disc to close the contacts 26, 28. The mechanism is then in the position shown in FIGURE 4. In addition, movement of the core 18 has served through the arm 51 to move the contacts 47, 48 into contact with the casing of the relay coil 46, whilst maintaining the contacts closed.

As will be seen from FIGURE 3, closing of the contacts 26, 28 permits current flow through the auxiliary field winding 53 to energize the motor at low power. The resulting slow rotation of the armature serves through the connection 16 to slide the pinion 14 into full engagement with the wheel 15. At the same time, the ball 44 drops into the recess 45 to locate the sleeve 13 relative to the spindle 11. Moreover, the collar 35 contacts the tail 38 to trip the catch 34 so that the contacts 25, 27 close. The mechanism is now in the position shown in FIGURE 5.

As soon as the contacts 25, 27 close, current flows in the windings 52 as well as the winding 53 and the motor is energised at full power. When the engine has started, the switch 55 should be re-opened, in which case the spring 17 disengages the pinion 14 and toothed wheel 15, the various parts then being returned to their rest positions.

It will be seen from FIGURE 3 that the winding 19 is connected in parallel with the windings 52, 53 when

the various contacts are closed. The winding 19 is thus connected across a part of the circuit in which the current flow is inversely proportional to the speed of the motor. When the engine has not started the current flow in the winding 19, and hence the voltage drop across it, is high, and the power available in the solenoid is sufficient to overcome the action of the springs 32 and 31, which are urging the core 18 to the left as shown in FIGURE 3. However, if when the engine starts the switch 55 is held closed, the voltage drop across the winding 19 falls until at a predetermined engine speed the power available in the solenoid is insufficient to overcome the action of the springs 32 and 31. The springs 32 and 31 now move the core 18 to the left so that the catch 44, 45 is released and the spring 17 can disengage the toothed wheel and the pinion. The parts are now in their rest position. If the switch 55 is still held closed, re-energization of the winding 19 is prevented by the contacts 47, 48. Normally these contacts return to their rest position under the resilience of the blades on removal of the arm 51 without opening, but if the arm 51 is removed without the switch 55 open, the relay coil 46 is still energized and the attraction between its casing and the contact 48 holds the contact 48 in position, so that contacts 47, 48 open.

Referring now to FIGURE 6, the circuit there shown illustrates two modifications of the circuit shown in FIGURE 3, those modifications being independent of each other but shown in the same drawing for convenience. It will be seen that in this example the motor is energized at low power by supplying current to all its field windings 52 through a resistor 62 which is short-circuited when the contacts 25, 27 close. Moreover, the action of the winding 19 is supplemented by a winding 61 having one end connected to a point intermediate the winding 19 and armature 12 and its other end earthed. The winding 61, which may be wound on the same core as the winding 19, supplements the action of the winding 19 and so increases the motor speed at which the pinion and toothed wheel are disengaged.

The invention is equally applicable to other forms of starting mechanism provided that the winding 19 is connected across a part of the circuit in which the current flow is inversely proportional to the motor speed. Thus, in the example shown in FIGURE 7 (in which for convenience components having the same functions as the components in FIGURES 3 and 6 are designated with the same reference numerals), the invention is shown applied to a mechanism in which the solenoid 19 effects full engagement between the pinion and toothed wheel, there being no energization of the motor at low power. When the pinion and toothed wheel are engaged, a switch 63 closes to energize the motor at full power. FIGURE 7 illustrates a compound motor, but the circuit is similar for a series motor.

FIGURE 8 illustrates a modification of FIGURE 7 applied to a series motor having a resistor 64 in series with the switch 63. In this case it is possible to connect the winding 19 across the switch 63 and resistor 64 in the manner shown.

FIGURE 8 also illustrates an important modification which is applicable to all the other examples described. The relay contact 56 has been omitted, and connection from the winding 19 to the source 54 made through the switch 55. In this case, the purpose of the coil 46 is solely to effect separation of the contacts 47, 48. The inclusion of the contact 56 is preferred because the voltage drop across the winding 19 is not then dependent on the resistance of the leads to the switch 55. However, the mechanism will operate satisfactorily without the contact 56 provided that this resistance is carefully controlled.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. Starting mechanism for an internal combustion engine having a toothed wheel rotatable therewith, comprising a motor having an armature spindle, a pinion rotatable with the armature spindle, a solenoid for moving the pinion into engagement with said toothed wheel, a pair of normally closed contacts in series with the winding of said solenoid, resilient means acting to disengage the pinion and toothed wheel, a starter switch for energizing the solenoid through said pair of normally closed contacts, a motor-energizing circuit including a motor switch, means for closing the motor switch when the pinion and toothed wheel are in engagement, means connecting the winding of the solenoid across a part of said motor-energizing circuit in which the current flow is inversely proportional to the speed of the motor, said resilient means overcoming the action of the solenoid when the engine has started and the starter switch is maintained closed to disengage the pinion and toothed wheel, and means for opening said pair of contacts when the pinion and toothed wheel are disengaged with the solenoid energized, whereby to prevent re-engagement of the pinion and toothed wheel.

2. Starting mechanism as claimed in claim 2 in which one of said pair of contacts is formed from magnetic material, said means for opening said pair of contacts comprising a relay casing supported by said mechanism and containing a relay coil in circuit with said starter switch so that the relay coil is energized when the starter switch is closed, means mounting said pair of contacts on the mechanism so that they are spaced from the casing of the relay by a sufficient distance to ensure that said one contact is not attracted into contact with the casing when the relay is energized, and an arm movable with said pinion and adapted to move said pair of contacts to a position in which said one contact is in contact with the casing of the relay but said pair of contacts are still closed, said arm being removed from the pair of contacts when the pinion and toothed wheel are disengaged, and said contacts then returning to their normal position unless the relay is still energized, in which case said one contact is attracted to said casing and the contacts become separated.

3. Starting mechanism as claimed in claim 2 including a normally open contact operable by said relay and controlling current flow through the solenoid winding.

4. Starting mechanism as claimed in claim 1 including a relay in series with said starter switch so as to be energized on closing of the starter switch, said relay having a normally open contact through which current flows to the solenoid winding when the relay is energized.

5. Starting mechanism as claimed in claim 1 in which the solenoid winding is energized directly through the starter switch.

6. Starting mechanism as claimed in claim 1 including an additional winding in circuit with said solenoid winding for supplementing the action thereof.

7. Starting mechanism as claimed in claim 1 in which said motor includes a plurality of field windings and said solenoid winding is connected across one of the field windings.

8. Starting mechanism as claimed in claim 1 in which said motor includes a plurality of field windings, and a resistor in series with one of said field windings, said solenoid winding being connected across said resistor.

9. Starting mechanism for an internal combustion engine having a toothed wheel rotatable therewith, comprising a motor having an armature spindle and a plurality of field windings, a pinion rotatable with the armature spindle, a solenoid for moving the pinion into engagement with said toothed wheel, a pair of normally closed contacts in series with the winding of said solenoid, resilient means acting to disengage the pinion and toothed wheel, a starter switch for energizing the solenoid through said pair of normally closed contacts, first and second motor-energizing circuits for energizing the motor at reduced power and full power respectively, first and second motor switches in said first and second motor-energizing circuits respectively, means for closing said first motor

switch when the pinion and toothed wheel are moved into partial engagement by the action of said solenoid, the motor then being operated at reduced power, means operable upon operation of the motor at reduced power for moving the pinion and toothed wheel into full engagement, means for closing said second motor switch when the pinion and toothed wheel are in full engagement, the motor then being operated at full power, means connecting the winding of the solenoid across a part of one of said motor-energizing circuits in which the current flow is inversely proportional to the speed of the motor, said resilient means overcoming the action of the solenoid when the engine has started and the starter switch is maintained closed to disengage the pinion and toothed wheel, and means for opening said pair of contacts when the pinion and toothed wheel are disengaged with the solenoid energized, whereby to prevent re-engagement of the pinion and toothed wheel.

10. Starting mechanism as claimed in claim 9 in which said first motor switch completes a circuit through a proportion of said field windings, and said second motor switch completes a circuit through all of the field windings.

11. Starting mechanism as claimed in claim 9 in which said first motor switch completes a circuit through a resistor to all of the field windings, and said second motor switch serves to short-circuit said resistor.

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