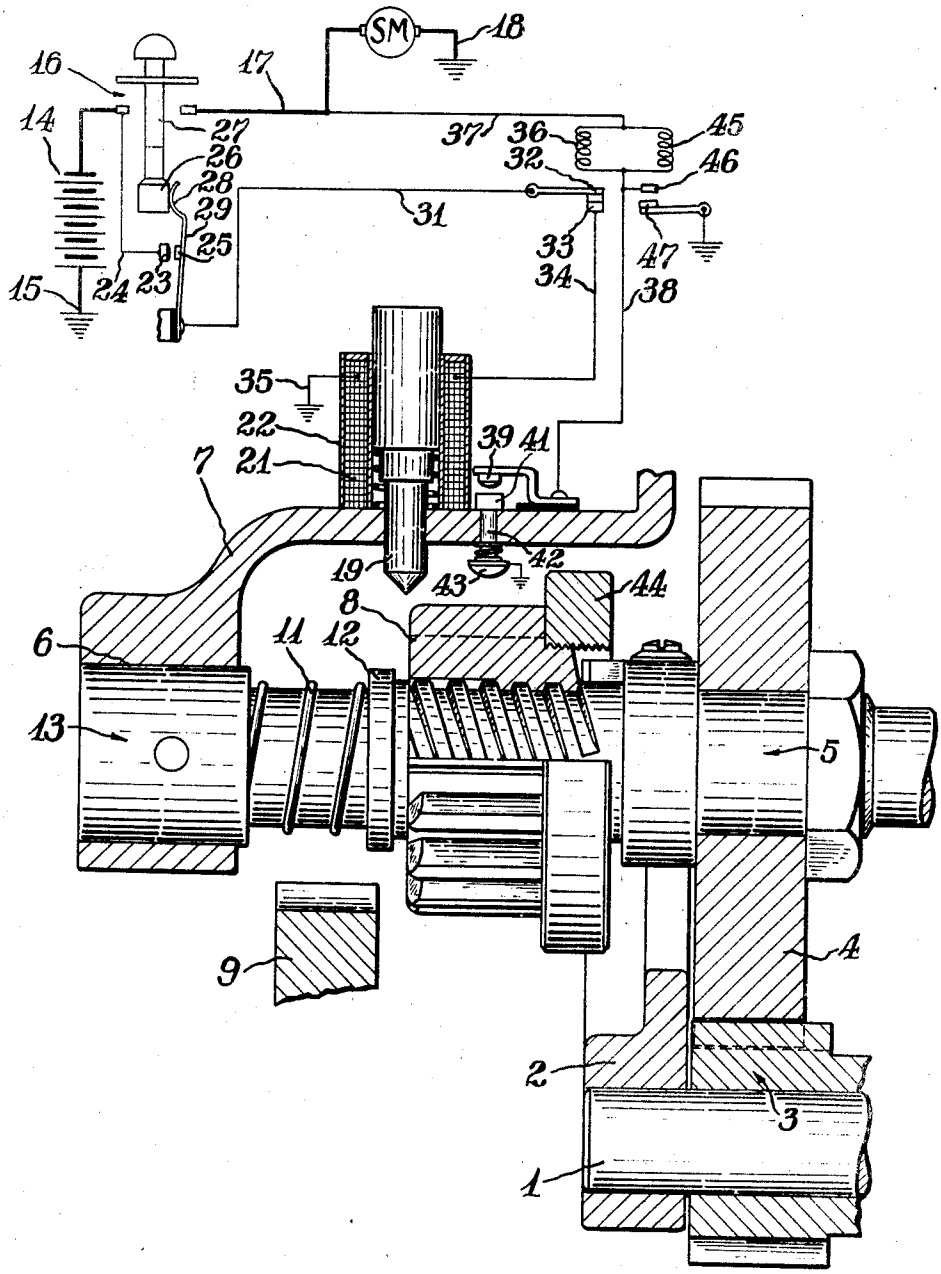
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ENGINE STARTER GEARING

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ENGINE STARTER GEARING

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The present invention relates to engine starter gearing and more particularly to an arrangement for ensuring traversal of a starter pinion into mesh with an engine gear when the starting motor is actuated.

In starter gearing of the type in which the pinion has a threaded connection to the starting motor for securing automatic engagement with an engine gear, difficulty is sometimes encountered in obtaining traversal of the pinion without rotation prior to such engagement. This difficulty is aggravated in cold weather since the lubricant used on the threaded connection may congeal and strongly resist the longitudinal movement of the pinion.

It is an object of the present invention to provide a novel detent arrangement for resisting initial rotation of a threaded pinion in a starter drive which is efficient and reliable in operation and simple in construction.

It is another object to provide such a device in which the detent is moved into engagement with the pinion before the starting motor is energized.

It is another object to provide such a device in which the detent is retracted from the pinion as soon as the pinion is meshed with the engine gear.

It is a further object to provide such a device in which the reactuation of the detent is prevented until such time as the starting switch is opened and the starting motor has come substantially to rest.

Further objects and advantages will be apparent from the following description taken in connection with the accompanying drawing in which the figure illustrates semi-diagrammatically a preferred embodiment of the invention as applied to a conventional form of double reduction starter drive.

In the drawing there is illustrated a power shaft 1 journalled in a bearing 2 of the housing of the starting motor illustrated diagrammatically at SM. A pinion 3 is fixed in any suitable way on the power shaft and is arranged to mesh with a driven gear 4 fixed on a screw shaft 5, one end of which is journalled in a bearing 6 in an extension 7 of the motor housing.

A starter pinion 8 is threaded on the screw shaft for longitudinal movement into and out of engagement with a gear 9 of an engine to be started. The pinion is normally maintained in its idle position as illustrated by means of an anti-drift spring 11, and the operative position of the pinion is defined by the abutment of a sliding collar 12 against a thrust and bearing member 13 fixed on the screw shaft.

A cranking system for energizing the power shaft 1 is provided comprising a starting circuit including a battery 15 grounded at 15 and connected through a starting switch 16 and lead 17 to the starting motor SM which is grounded at 18 to complete the starting circuit.

According to the present invention means are provided for ensuring the longitudinal movement of the starter pinion 8 by resisting its rotation when the screw shaft 5 is initially rotated by the power shaft 1. As shown, this means is in the form of a detent member 19 slidably mounted in the extension 7 of the motor housing, normally maintained out of engagement with the pinion by means of a retracting spring 21, and adapted to be projected into engagement with the pinion teeth by a solenoid 22. Means for energizing the solenoid 22 upon initial closing movement of the starting switch 16 is provided including a contact 23 connected by a lead 24 to the battery side of the starting switch 16, and a contact 25 mounted on a spring 29 and normally held out of engagement with contact 23 by an enlargement 26 of the stem 27 of the starting switch engaging the free end 28 of said spring. Contact 25 is connected by a lead 31 to a relay contact 32 which is normally in engagement with a contact 33 connected by a lead 34 to the solenoid 22, said solenoid being grounded at 35 to complete the detent circuit.

Means for opening the relay contacts 32, 33, to permit withdrawal of the detent when the pinion 8 is meshed with the engine gear is provided in the form of a relay circuit including a coil 36 connected by a lead 37 to the starting motor lead 17 and by a lead 38 to an insulated contact 39 mounted on the motor housing. A grounded contact 41 is fixed on a stem 42 slidably mounted in the motor housing and having a tapered or rounded head 43 adapted to be engaged by a counter-weight flange 44 on the pinion when the pinion has moved longitudinally sufficiently for its teeth to enter into mesh with the teeth of the engine gear 9. The engagement of the flange 44 cams the contact 41 into engagement with contact 39, thus completing the relay circuit and thereby opening the relay contacts 32, 33.

In order to hold said contacts open as long as the starting switch 16 is held closed, a lock-out circuit is provided including a coil 45 in parallel with the relay coil 36 and adapted when energized to close a pair of grounding contacts

46, 47. It will be understood that the grounding contacts may be controlled by the relay coil 36 along with the contacts 32, 33 if so desired. Coils 45 and 36 are preferably provided with magnetic circuits which are closed when their armatures are attracted and the coils are designed to hold said armatures responsive to the feeble current generated by the starting motor when spinning by momentum in its residual field after the starting switch 16 is opened. This provides a time delay which prevents re-actuation of the detent while the starting motor is spinning, and thereby protects the starting system against "spinning meshes" which might be caused by careless repetitious actuation of the starting switch.

In operation, starting with the parts in the positions illustrated, depression of the starting switch 16 first causes closure of contacts 23, 25, thus completing the detent circuit and causing the detent 19 to be projected into engagement with the pinion so as to resist its rotation. Further depression of the starting switch causes completion of the cranking circuit and consequent energization of the starting motor to rotate the power shaft 1. This rotation is transmitted to the screw shaft 5 which thereupon traverses the starting pinion into mesh with the engine gear 9. The engagement of the pinion flange 44 with the head 43 of the sliding stem 42 causes contact 41 to engage contact 39, completing the relay circuit through coil 36 which thereupon opens contacts 32, 33 and de-energizes the detent solenoid 35. Lock-out coil 45 is energized concomitantly with relay coil 36, causing closure of contacts 46, 47, whereby the relay circuit is maintained closed irrespective of contacts 39, 41.

When the engine starts, the starting pinion 8 is traversed back to its idle position by the overrunning action of the engine gear 9 and contacts 39, 41 are thus permitted to open. Relay contacts 32, 33 are, however, maintained open by coil 36 as long as the starting switch 16 is closed.

When the operator releases the starting switch, the connection from the relay circuit to the battery is broken. However, contacts 32, 33 of the detent circuit are held open by the coil 36 as long as it is energized by the current produced by the starting motor acting as a generator during its period of deceleration. If at this time the operator should inadvertently reclose the starting switch 16, the contacts 23, 25 will be closed, and the starting motor will be re-energized. The detent 19 will not be projected against the pinion however, since the detent circuit is open at contacts 32, 33. The pinion will consequently not be forced against the engine gear 9 but at most will merely strike against the engine gear and then rotate idly with the screw shaft. All danger of milling action of the starting pinion on the engine gear is thus obviated.

Although but one embodiment of the invention has been shown and described in detail, it will be understood that other embodiments are possible and that various changes may be made in the design and arrangement of the parts without departing from the spirit of the invention as defined in the claims appended hereto.

What is claimed is:

1. In an engine starting system a starting motor, a starting switch, a pinion having a threaded connection to the starting motor, a detent for resisting rotation of the pinion to ensure its traversal when the starting motor is energized, means energized by closure of the starting switch for actuating the detent, and means actuated by movement of the pinion to operative position for releasing the detent and preventing re-actuation thereof.

2. In an engine starting system a starting motor, a starting switch, a pinion having a threaded connection to the starting motor, a detent for resisting rotation of the pinion to ensure its traversal when the starting motor is energized, means energized by initial closing movement of the starting switch for actuating the detent, means actuated by movement of the pinion to operative position for releasing the detent, and means energized concomitantly with the releasing means under the control of the starting switch for preventing re-actuation of the detent.

3. In an engine starting system a starting motor, a starting switch, a pinion having a threaded connection to the starting motor, a detent for resisting rotation of the pinion to ensure its traversal when the starting motor is energized means including an electromagnet for moving the detent into engagement with the pinion, and a circuit including contacts closed by the starting switch for energizing said electromagnet, means responsive to movement of the pinion to operative position for opening said detent circuit, and means controlled by the starting switch for thereafter holding said detent circuit open.

4. In an engine starting system a starting motor, a starting switch, a pinion having a threaded connection to the starting motor, a detent for resisting rotation of the pinion to ensure its traversal when the starting motor is energized, means including an electromagnet for moving the detent into engagement with the pinion, and a circuit including contacts closed by initial closing movement of the starting switch for energizing said electromagnet, means including a relay for opening the detent circuit, a circuit for said relay including normally open contacts, and means actuated by the pinion when in operative position to close said contacts.

5. An engine starting system as set forth in claim 4 including, further, means controlled by the starting switch for maintaining the relay circuit energized.

6. In an engine starting system a starting motor, a starting switch, a pinion having a threaded connection to the starting motor, a detent for resisting rotation of the pinion to ensure its traversal when the starting motor is energized, means energized by closure of the starting switch for actuating the detent, means actuated by movement of the pinion to operative position for releasing the detent, and means for preventing re-actuation of the detent until the starting motor comes substantially to rest.

7. In an engine starting system a starting motor, a starting switch, a pinion having a threaded connection to the starting motor, a detent for resisting rotation of the pinion to ensure its traversal when the starting motor is energized, means energized by closure of the starting switch for actuating the detent, means for releasing the detent, means energized by the starting switch for preventing re-actuation of the detent, said means being energized by current from the starting motor spinning in its residual field to prevent actuation of the detent until after the starting motor comes substantially to rest.

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