

April 27, 1943.

E. E. HOOD

2,317,344

ENGINE STARTER

Filed March 4, 1942

2 Sheets-Sheet 1

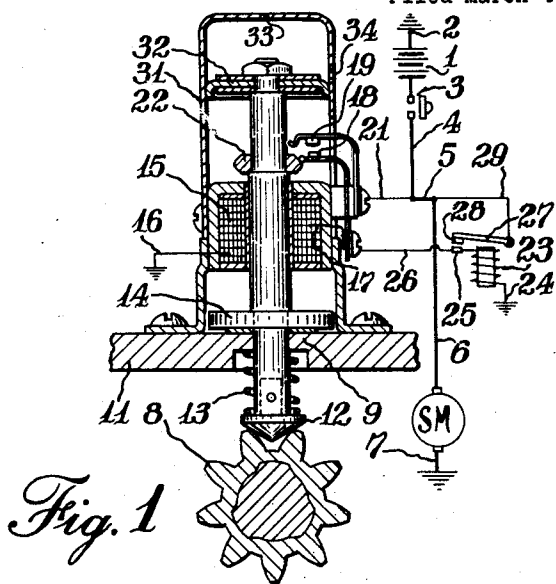
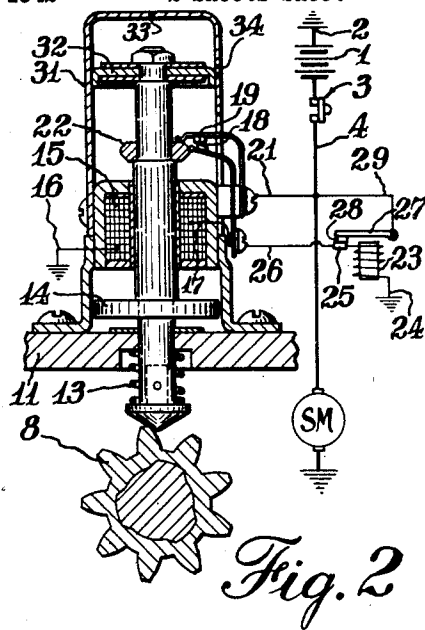
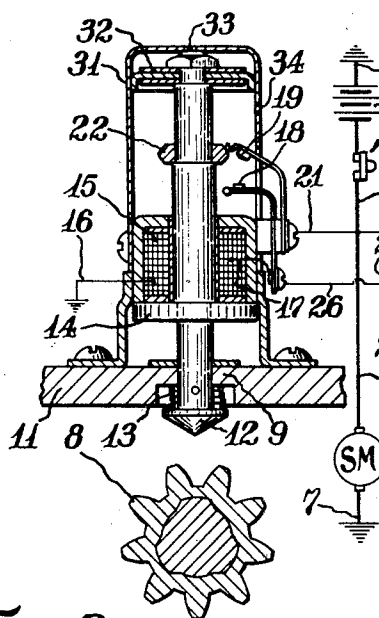
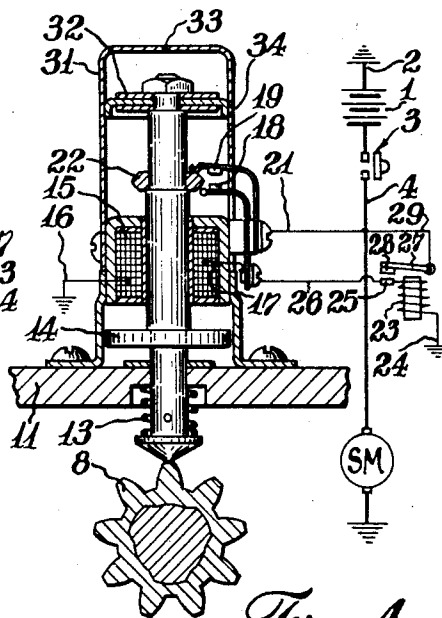


*Fig. 3*

*Fig. 4*

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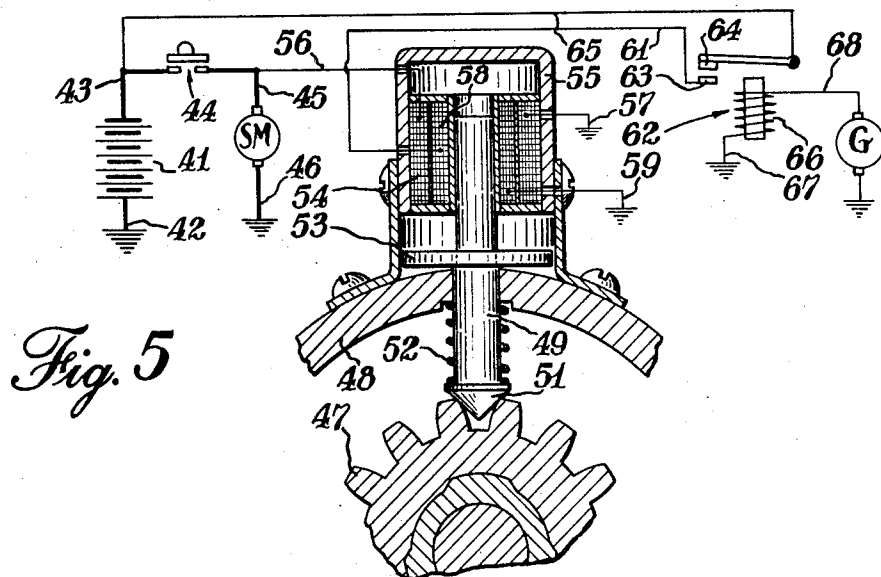
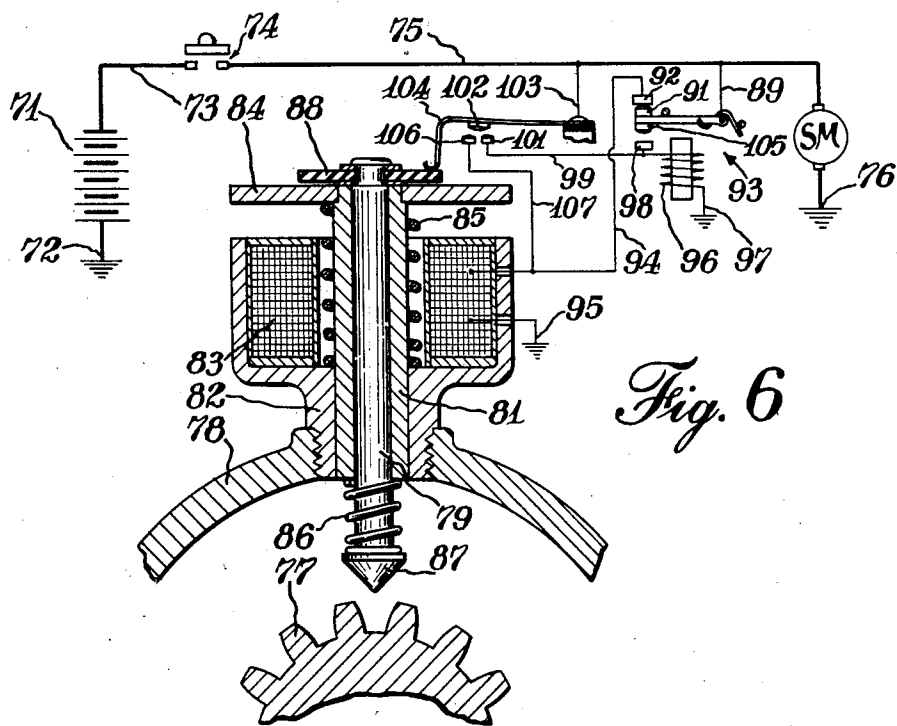
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ENGINE STARTER

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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

2,317,344

## ENGINE STARTER

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Application March 4, 1942, Serial No. 433,303

8 Claims. (Cl. 290—38)

The present invention relates to engine starters and more particularly to an automatically operated detent for ensuring engagement of starter gearing.

It is an object of the present invention to provide a novel detent-actuating system for a starter drive pinion 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 arranged to engage the drive pinion until it is fully meshed with its engine gear.

It is another object to provide such a device incorporating a lock-out structure for preventing the detent from engaging the pinion when it is rotating, whether or not it is meshed with the engine gear.

It is another object to provide such a device in which the initial rotation of the pinion after it is meshed with the engine gear is caused to eject the detent from the pinion.

It is another object to provide such a device having means brought into operation by such ejection of the detent for withdrawing the detent from the pinion and holding it out of engagement therewith.

Further objects and advantages will be apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a semi-diagrammatic illustration of an engine starting system incorporating a preferred form of detent-actuating means, the detent-actuating means being shown in side elevation partly broken away and in section.

Fig. 2 is a similar view showing the parts in the positions occupied at the initiation of the cranking operation.

Fig. 3 is a similar view showing the parts in their positions during cranking.

Fig. 4 is a similar view showing the parts in the positions assumed in case the detent comes to rest on top of a tooth of the starting pinion.

Fig. 5 is a view similar to Fig. 1 of a second embodiment of the invention; and

Fig. 6 is a similar view of a third embodiment of the invention.

In Fig. 1 of the drawings there is illustrated a starting system including a battery 1 grounded at 2 and connected through a starting switch 3 and leads 4, 5 and 6 with a starting motor SM which is grounded at 7 to complete the starting circuit.

A pinion 8 is adapted to be rotated by the starting motor by means of a threaded connection

of conventional form not illustrated, the threaded connection being effective to traverse the pinion longitudinally into and out of operative position. According to the present invention a detent is provided for resisting rotation of the pinion upon initial actuation of the starting motor in order to ensure traversal of the pinion into operative position. As here shown this detent is in the form of a plunger 9 slidably mounted in a housing 11 and having at its lower end a head 12 of tapered form adapted to engage between the teeth of the pinion under the impulsion of a spring 13.

Means for retracting the detent is provided in the form of an armature 14 of magnetic material fixedly mounted on the plunger 9, and an electromagnetic coil 15, one end of which is grounded as indicated at 16, and the other end of which is connected by a lead 17 to a spring-mounted contact 18. A second spring-mounted contact 19 is located adjacent contact 18 and connected by a lead 21 to the starting circuit lead 4.

Means for controlling contacts 18, 19 is provided in the form of a collar 22 fixed on the plunger 9 and having a beveled surface adapted to engage the ends of the springs on which said contacts are mounted so as to cause engagement and disengagement of the contacts.

Means for maintaining the energization of the coil 15 after initial closure of its circuit through contacts 18, 19 is provided in the form of a holding relay including a coil 23 grounded at one end at 24 and connected at its other end to a fixed contact 25 which is connected by a lead 26 to the lead 17 of coil 15. The holding relay also includes an armature 27 provided with a movable contact 28 adapted to cooperate with fixed contact 25 and connected by a lead 29 with the lead 5 of the starting circuit.

Means for retarding engaging movement of the detent is provided in the form of a dash-pot composed of a cylindrical casing 31 constituting the enclosing means for the detent-actuating structure, and a piston 32 fixed on the upper end of the plunger 9. A small bleeder opening 33 is provided in the top of the cylinder 31 for regulating the descent of the piston and plunger, and a port 34 in the side of the cylinder is provided for breaking the vacuum in the cylinder after a predetermined travel of the detent plunger.

In the operation of this embodiment of the invention, starting with the parts in the positions illustrated in Fig. 1, closure of the starting switch 3 by the operator causes actuation of the starting motor and since the rotation of the pinion is

resisted by the detent 9, the pinion is projected longitudinally toward operative position. When the traversal of the pinion is completed it is constrained to rotate with the starting motor. The teeth of the pinion then cam the detent upwardly into the position illustrated in Fig. 2 where the collar 22 on the plunger 9 moves the contact 18 into engagement with contact 19. Circuits are thus completed through the holding relay coil 23 and through the detent-retracting coil 15 causing energization thereof. Contacts 28, 25 are thereby closed by coil 23 completing the holding circuit for coil 15, and the coil 15 is caused to retract the detent into the position shown in Fig. 3. It will be noted that during this retraction of the detent the collar 22 passes by and releases the contact 18, and thereafter moves contact 19 away from contact 18, thus breaking the circuit there-through. Since contacts 28, 25 have been closed by coil 23, however, the holding circuit is at this time completed and the coil 15 is maintained energized as long as the starting switch is held closed by the operator.

When the engine starts, the opening of the starting switch by the operator permits the parts to return to their idle positions as illustrated in Fig. 1. The return of the detent into engagement with the starting pinion is delayed however by the dash pot 31, 32, whereby it is prevented from engaging the pinion until after the pinion comes to rest.

It will occasionally happen that when the detent 12 is permitted to return to its idle position, it may come to rest on top of a tooth of the pinion 8 as illustrated in Fig. 4. The contacts 19, 21 will then be disengaged as illustrated with the collar 22 on the plunger located between the springs carrying said contacts, and the piston 32 adjacent the port 34.

Upon re-actuation of the starting system with the parts in this condition, if the pinion starts to rotate instead of traverse, initial rotation permits the detent to snap into its operative position as shown in Fig. 1 under the pressure of spring 13, and the further operation of the starting system takes place in the usual manner.

In the embodiment of the invention illustrated in Fig. 5, locking means is provided for maintaining the detent inoperative during self-operation of the engine to be started.

In this figure there is illustrated a starting system comprising a battery 41 grounded at 42 and connected by a lead 43 to a starting switch 44 which in turn is connected by a lead 45 to the starting motor SM, grounded at 46 to complete the starting circuit. A starting pinion 47 is mounted within a housing member 48 and a detent 49 is slidably mounted in the housing with its lower tapered end 51 normally held in engagement with the teeth of the pinion by a spring 52.

Means for withdrawing the detent from the pinion is provided in the form of an armature 53 of magnetic material fixed to the detent 49 and an electro-magnetic coil 54 mounted in a casing 55 in position to attract said armature. One end of the coil is connected by a lead 56 to the starting motor lead 45, and the other end is grounded at 57 to complete its energizing circuit.

In order to maintain the detent 49 in retracted position as long as the engine is self-operative, a second coil 58 is arranged co-axially with the coil 54 and provided with means for maintaining its energization during self-operation of the engine. For this purpose one end of the coil is grounded 75

as shown at 59 and the other end is connected by a lead 61 to a lock-out relay indicated generally by numeral 62. This relay comprises a fixed contact 63, a movable contact 64 which is connected by a lead 65 to the battery lead 43 and a coil 66 grounded at one end at 67 and connected at the other end by a lead 68 to an engine driven generator G.

In the operation of this embodiment of the invention, closure of the starting switch 44 completes the starting circuit, causing energization of the starting motor. At the same time a circuit is completed through the retracting coil 54, but since the starting motor when at rest has a very low resistance, the coil 54 is not energized sufficiently to retract the detent until the starting motor has accelerated to a substantial rotative speed. The withdrawal of the detent by the coil 54 thus occurs substantially concurrently with the arrival of the pinion at its operative position. This withdrawal is therefore initiated jointly by the action of the coil 54 and by the camming action of the pinion teeth against the tapered extremity of the detent.

As soon as the engine becomes self-operative, the generator G becomes effective to energize the lock-out relay coil 66 to close contacts 64, 63, thus causing energization of the lock-out coil 58 which thereafter holds the detent retracted as long as the engine remains in operation, irrespective of opening of the starting switch 44. When the engine stops, the lock-out relay 62 becomes de-energized and the parts return to their idle positions as illustrated.

In the embodiment of the invention illustrated in Fig. 6, a form of detent is shown which is normally disengaged from the starting pinion and is only caused to engage the pinion by closure of the starting circuit.

As here shown, the starting circuit comprises a battery 71 grounded at 72, connected by a lead 73 to a starting switch 74. Switch 74 is connected by a lead 75 to the starting motor SM which is grounded at 76 to complete the starting circuit.

A starting pinion 77 is mounted in a housing 78, and a detent 79 is slidably mounted in the housing in position to engage said pinion. As illustrated, the detent 79 is slidably mounted within a hollow plunger 81 which in turn is slidably mounted in a casing member 82 threaded into the housing 78. An electro-magnetic coil 83 is seated in housing 82, and an armature 84 of magnetic material is fixed to the upper end of the hollow plunger 81 in position to be attracted by the coil. A spring 85 normally maintains the armature 84 spaced from the end of the coil 83 and a spring 86 bears against the tapered end 87 of detent 79 and yieldingly maintains the detent projecting from the hollow plunger. A disc 88 of insulating material is fixed on the upper end of the detent, normally in abutting relation with the end of plunger 81 and thereby limits the projection of the detent from the plunger.

Means for energizing the coil 83 to attract the armature 84 and thus project the detent into engagement with the pinion is provided in the form of a closing circuit for said coil comprising a lead 89, normally closed contacts 91, 92 of a relay 93, and a lead 94 connected to one end of the coil, the opposite end of the coil being grounded as shown at 95. Means for retracting the detent as soon as positive rotation of the pinion has started is provided in the form of a lock-out circuit comprising a coil 96 for relay

93 which coil is grounded at one end at 97 and connected at its other end to a fixed contact 98. Contact 98 is connected by a lead 99 to a fixed contact 101 adjacent a spring-mounted contact 102 which is connected by a lead 103 to the starting circuit lead 75.

Contact 102 is mounted on a spring 104, the end of which normally bears on the insulated disc 88 so as to maintain contact 102 out of engagement with contact 101. When the plunger 81 is moved to project the detent into engagement with the pinion however, contact 102 is permitted to engage contact 101 thereby energizing the coil 96 of the lock-out relay. A contact 105 is provided in the relay 93 for engagement with fixed contact 98 whereby the coil 96 is maintained energized as long as the starting circuit is closed, thus maintaining contacts 91, 92 open and thereby breaking the circuit to the detent-actuating coil 83.

In order to prevent premature release of the detent, a contact 106 is provided which is adapted to be engaged by the contact 102 at the same time that it engages contact 101, and contact 106 is connected by a lead 107 to the detent coil 83.

In operation, closure of the starting switch 74 energizes the starting motor SM and at the same time completes a circuit through contacts 91, 92 and lead 94 to the detent-actuating coil 83 which thereon projects the lower end 87 of the detent into engagement with the pinion 77 to resist its rotation in order to ensure its traversal. The movement of the disc 88 with the plunger 81 permits contact 102 to engage contacts 101 and 106. The engagement of contact 102 with contact 101 completes the circuit through the lock-out relay coil 96 whereby contacts 91, 92 are opened and contacts 98, 105 closed. Closure of contacts 102 and 106 maintains the energization of the coil 83 and holds the detent in operative position.

As soon as the pinion reaches the end of its longitudinal travel and is thus constrained to rotate with the starting motor, the teeth of the pinion cam up the detent 79, compressing the spring 86, and causing the disc 88 to raise the contact 102 out of engagement with contacts 101 and 106. The coil 83 is thereby de-energized and the plunger 81 raised to its idle position by the spring 85. When the engine starts, opening the starting switch de-energizes the lock-out coil 96 and the relay contacts 91, 92 are permitted to close preparatory to the next operation of the starting system.

Although certain embodiments of the invention have 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 starter a drive pinion, a detent, means causing the detent to engage the teeth of the pinion and resist its rotation, and means

responsive to the ejection of the detent from the teeth of the pinion by the initial rotation of the pinion for withdrawing the detent and maintaining it retracted from the pinion.

2. An engine starting system as set forth in claim 1 including further, means responsive to self-operation of the engine for holding the detent retracted.

3. In an engine starter a drive pinion, a detent comprising a plunger with a tapered head adapted to engage between the teeth of the pinion, spring means normally holding the detent engaged with the pinion, magnetic means for withdrawing the detent from the pinion when the pinion is rotated, and means for thereafter maintaining the magnetic means energized to hold the detent retracted.

4. An engine starting system as set forth in claim 3 including further, means for delaying the return of the detent for a predetermined time after de-energization of the magnetic means.

5. In an engine starter a pinion, a detent for resisting rotation thereof, electro-magnetic means energized concurrently with the engine starter for moving the detent into engagement with the pinion, and means responsive to the ejection of the detent by rotation of the pinion for de-energizing said electromagnetic means.

6. An engine starter as set forth in claim 5 including further, means for preventing re-actuation of the detent during energization of the starting motor.

7. In an engine starting system a cranking circuit including a starting switch and a motor, a pinion actuated by the motor, a detent for resisting rotation of the pinion, electromagnetic means for moving the detent into engagement with the pinion, a circuit controlled by the starting switch for energizing the electromagnetic means, a holding circuit for the electromagnetic means closed by movement of the detent into engagement with the pinion, a pair of contacts in said energizing circuit, means for opening said contacts concurrently with closure of the holding circuit, and means controlled by the starting switch for holding the contacts open.

8. In a starting system for internal combustion engines a starting motor, a pinion having a threaded connection therewith for movement into and out of engagement with a member of an engine to be started, a detent having a tapered head adapted to engage between the teeth of the pinion and resist its rotation to ensure its traversal into mesh with the engine member, means effective when the starting motor is initially energized to press the detent into the pinion, means limiting the traversal of the pinion to thereby constrain it to rotate with the starting motor, whereby the teeth of the pinion eject the detent therefrom, and means brought into action by such ejection to withdraw the detent from engagement with the pinion.

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