Oct. 21, 1947. J. E. BUXTON 2,429,388

ENGINE STARTER

Filed June 23, 1944

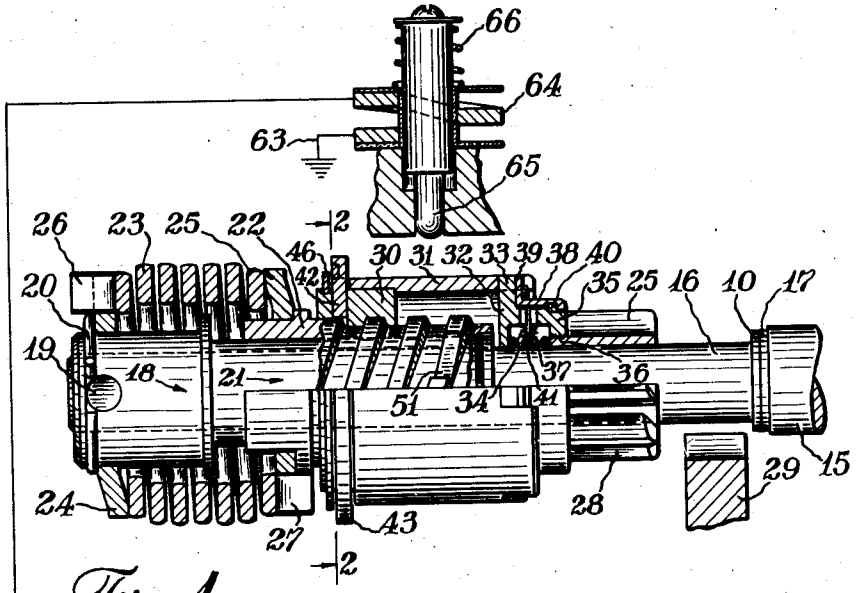


Fig. 1

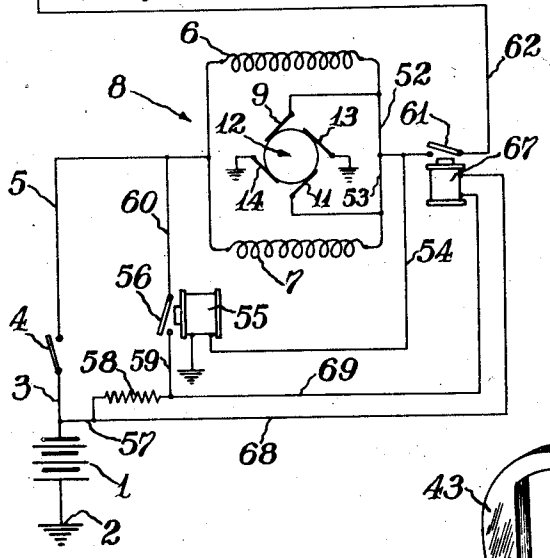
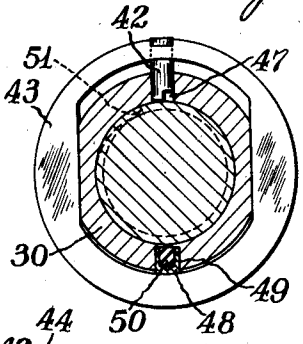


Fig. 2



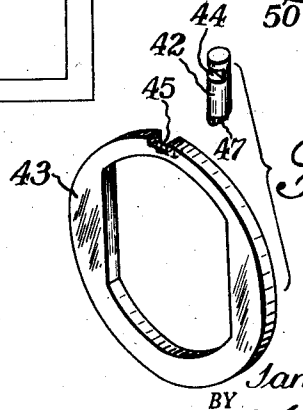


Fig. 3

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Patented Oct. 21, 1947

2,429,388

UNITED STATES PATENT OFFICE

2,429,388

ENGINE STARTER

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Application June 23, 1944, Serial No. 541,702

6 Claims. (Cl. 290—38)

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The present invention relates to an engine starter, and more particularly to a starting system incorporating gearing of the type in which energization of the starting motor automatically effects engagement of the gearing and such engagement is maintained until the engine is reliably self operative, whereupon the acceleration of the engine gear is permitted to disengage the gearing.

In starter gearing of the above indicated type, it is usual to provide an overrunning connection to the starting pinion in order to prevent the engine from driving the armature of the motor which might cause it to rotate at a dangerously high speed. The use of such clutches, however, has been found in some instances to make the demeshing of the pinion somewhat sluggish and consequently noisy. Moreover, the types of overrunning clutch heretofore used have sometimes been undesirably noisy in operation.

It is an object of the present invention to provide a novel engine starter of the type which maintains its engagement with the engine until continuous self operation of the engine is secured, incorporating means to insure prompt disengagement of the drive on completion of the starting operation.

It is another object to provide such a device in which engagement of the drive is effected by acceleration of the starting motor, and prompt disengagement is insured by quick deceleration of the starting motor.

It is a further object to provide such a device in which the drive is held in engagement by a latch which is automatically tripped at the conclusion of the starting operation.

It is another object to provide such a device in which the tripping of the latch is simultaneous with the deceleration of the starting motor.

It is another object to provide such a device incorporating an overrunning clutch which forms a reliable and positive driving connection, and overruns freely and quietly.

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

Fig. 1 is a side elevation partly in section of a preferred embodiment of the invention; the electrical circuits involved being shown diagrammatically;

Fig. 2 is a section taken substantially on the line 2—2 of Fig. 1; and

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Fig. 3 is a detail in perspective of the latch pin and its actuating member.

In the drawing there is illustrated a starting system including a battery 1 grounded at 2 and connected by a lead 3 to a starting switch 4 conveniently located for control by the operator of the engine to be started. Switch 4 is connected by a lead 5 to the field windings 6 and 7 of a starting motor 8. At their other ends the fields 6 and 7 are connected to the brushes 9 and 11 respectively, which conduct current through the armature 12 to the brushes 13 and 14 which are grounded to complete the starting circuit.

Means are provided for connecting the starting motor 8 to rotate a member such as a flywheel gear of the engine to be started. For this purpose, the starting motor is provided with an armature shaft 15 having a smooth reduced extension 16, the reduction in diameter being defined by a thrust shoulder 17 against which one or more thrust washers 10 are preferably seated. On the outer end of the extension 16 there is rigidly mounted a driving head 18 as by means of a cross pin 19 retained by a lock ring 20. The driving head 18 has a smooth cylindrical extension 21, and a screw shaft 22 is slidably journalled thereon and yieldably connected for rotation therewith by means of a torsion spring 23 anchored at its ends to the driving head and screw shaft by means of anchor plates 24 and 25. The anchor plates are non-rotatably mounted on the driving head and screw shaft and have slots adapted to receive the out-turned ends 26 and 27 of the spring, respectively.

A pinion 28 is slidably journalled on the extension 16 of the armature shaft for longitudinal movement into and out of engagement with a member such as a gear 29 of the engine to be started. Means for traversing the pinion into and out of operative position and for rotating the pinion is provided comprising a nut 30 threaded on the screw shaft 22 and rigidly connected at one end to a barrel member 31. The opposite end of the barrel is connected to the pinion by means of an overrunning clutch comprising a driving plate 32 anchored as indicated at 33 in the barrel and having clutch teeth 34 on its face. A driven clutch member 35 is fixed as indicated at 36 on the pinion and has teeth 37 adapted to engage with the teeth 34 of the driving clutch member. Means are provided for limiting the separation of the driving and driven clutch members and for transmitting a light frictional drag from the pinion to the barrel member, in the form of a thimble 38 anchored to the end of

the barrel 31 as indicated at 39 and having a swivel connection 40 with the pinion. A spring 41 located between the clutch members is arranged to hold said members normally out of engagement.

According to the present invention means are provided for maintaining the pinion 28 in engagement with the engine gear 29 until a successful start of the engine has been secured. As here shown this means comprises a latch pin 42 slidably mounted in the control nut 30, and an actuating member therefor in the form of a ring 43 slidably but non-rotatably mounted on the control nut. Pin 42 is provided with a notch 44 adapted to receive a reduced section 45 of ring 43 so as to couple the pin to the ring for sliding movement in unison. The ring is retained on the barrel by suitable means such as a lock ring 46.

The inner end of the pin 42 is preferably flattened as indicated at 47, and bears on the periphery of the screw shaft 22. Means for pressing the pin against the screw shaft is provided in the form of a plunger 48 slidably mounted in a recess 49 in the nut 30 opposite the pin 42, and a compression spring here shown as a rubber block 50 which presses the plunger 48 against the ring member 43. Screw shaft 22 is provided with a notch 51 in position to receive the end of latch pin 42 when the barrel assembly has moved the pinion 28 into mesh with engine gear 29. Engagement of the latch pin in notch 51 thus holds the pinion in mesh. When the pin 42 bears on the periphery of the screw shaft, the outer surface of ring 43 is substantially concentric with the axis of the drive. Entry of the pin into the notch 51, however, allows the spring pressed plunger 49 to slide the ring into a slightly eccentric position.

Means under the control of the operator are provided for tripping the latch and at the same time causing rapid deceleration of the starting motor in order to insure that demeshing of the pinion takes place promptly and without interference between the teeth of the pinion and the flywheel gear as the pinion moves out of mesh. In order to accomplish this result, recourse is had to the electrical braking device disclosed in the patent to Janes, Number 2,353,900, issued July 18, 1944, and assigned to the assignee of the present application.

For this purpose the junctions of field coils 6 and 7 of the starting motor with brushes 9 and 11, respectively, are connected by leads 52, 53 and 54 to an electromagnet 55 which is arranged when actuated to close a switch 56. Switch 56 controls a circuit which is in shunt with the starting switch 4 and comprises a lead 57 connected to the battery lead 3, a resister 58, a lead 59 and a lead 60 connected to the starting motor lead 5.

The braking effect of the motor is secured as described in said application by grounding the lead 54 which shortcircuits the armature 12 of the starting motor while maintaining the energization of the field coils 6 and 7. To this end a switch 61 is connected to the motor lead 54 and by a lead 62 to the ground at 63.

According to the present invention the flow of current through the grounding circuit 52, 53, 54, 61, 62, 63 is used to withdraw the latch 42 from the notch 51. For this purpose, a solenoid in the form of a single turn coil 64 is inserted in the ground lead 62 which solenoid is arranged when actuated to project a finger 65 into the path of rotation of the ring 43. Engagement of

the finger with the ring as it rotates, moves the ring into concentric relation with the axis of the drive, thereby raising the latch out of the notch 51 and freeing the barrel and pinion assembly for demeshing movement. The finger 65 is normally held out of engagement with the ring 53 by suitable means such as a spring 66.

Means are provided for closing the grounding switch 61 and simultaneously energizing the trip solenoid 64 immediately upon opening the starting switch 4. As shown, this means comprises an electromagnet 67 which is connected by leads 68 and 69 to the opposite ends of the resister 58 so that when a voltage drop occurs through the resister that voltage is impressed on the electromagnet to close said switch.

In operation, closure of the starting switch 4 by the operator causes energization of the starting motor 8 in the usual manner whereby rotation of the armature shaft 15 is transmitted through the spring 23 to the screw shaft 22, and the nut 30 is traversed along the screw shaft until the pinion 28 engages the thrust washer 10. Since the longitudinal movement of the pinion is thus arrested, it is compelled to rotate with the armature shaft and thereby rotates the engine gear 29 with which it is in mesh. At this time, the latch 42 has entered the notch 51 of the screw shaft under the pressure of the spring 50 so that backward movement of the barrel is limited by engagement of the latch in said notch. When the meshing movement of the pinion is arrested, further movement of the barrel compresses the spring 41 and closes the clutch 32, 35 whereby the pinion is rigidly connected for rotation with the barrel.

During the cranking operation rotation of the armature 12 of the starting motor causes the generation of a counter E. M. F. in said armature which voltage is expressed between the brushes 9 and 11 and the ground. This voltage is impressed upon the electromagnet 55 causing closure of switch 56. Since the starting switch 4 is closed, however, there is no voltage drop across the resister 58, and consequently the grounding switch 61 remains open.

When the engine fires, the pinion 28 is accelerated, backing off the barrel 31 sufficiently to permit the spring 41 to disengage the clutch members 32, 35 after which the pinion is free to overrun while further backward movement of the barrel is prevented by the latch pin 42. If the engine does not continue self operative, it slows down until the starting motor catches up with it and cranking is resumed, prompt closure of the clutch being assured by the light frictional connection between the pinion and barrel provided by the swivel connection 40.

When the engine has become reliably self operative, the operator opens the starting switch 4 whereupon the current through the starting motor is compelled to traverse the shunt circuit including the resister 58 and switch 56. The consequent voltage drop across the resister 58 energizes the electromagnet 67 to close the grounding switch 61 which shortcircuits the armature 12 causing a powerful braking effect to be applied to the starting motor. At the same time the coil 64 is energized to bring the finger 65 into the path of the latch ring 43 thus tripping the latch and permitting the nut 30 with its associated parts to be traversed back to idle position by the deceleration of the armature shaft. As soon as the starting motor comes substantially to rest, the counter E. M. F. of its armature dies out

and the voltage across its brushes is reduced substantially to zero whereupon the electromagnet **55** is deenergized, permitting switch **56** to reopen, thus breaking the starting motor circuit and permitting the grounding switch **61** to open and the trip finger **65** to return to its idle position.

Although but one form 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 circuit including a starting motor and a starting switch, means for rotating an engine from the starting motor including a screw shaft, a nut threaded thereon, and a pinion movable by the nut into and out of mesh with a gear of the engine to be started, a latch for holding the pinion in mesh with the engine gear, means responsive to opening the starting switch for retarding rotation of the starting motor and means responsive to actuation of the retarding means for tripping said latch.

2. An engine starting system as set forth in claim 1 including further an overrunning clutch connection between the nut and pinion.

3. In an engine starting system a starting circuit including a starting switch and a starting motor controlled thereby having a field and armature, means for connecting the starting motor to rotate an engine including a screw shaft, a nut threaded thereon and a pinion connected to the nut for movement thereby into and out of mesh with a gear of the engine to be started, a latch for holding the pinion in mesh with the engine gear, a magnetic trip for the latch, means for shortcircuiting the armature of the motor to arrest its rotation, said motor arresting means including means for actuating the magnetic trip.

4. An engine starting system as set forth in claim 3 in which said motor arresting means is arranged to open the motor circuit and release the magnetic trip when the starting motor comes substantially to rest.

5. In an engine starting system, a starting circuit including a motor and a starting switch, means for driving an engine from the motor including a pinion movable into and out of engagement with an engine gear, means responsive to acceleration of the motor for moving the pinion into mesh with the engine gear, and operative on deceleration of the motor to return the pinion to idle position, means for holding the pinion in mesh with the engine gear, means actuated by the opening of the starting switch for applying a braking force to decelerate the motor, and means energized by said decelerating means to release said holding means.

6. An engine starting system as set forth in claim 5 including further, an overrunning clutch connection between said moving means and the pinion.

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