Oct. 22, 1940. D. P. KEARNEY 2,218,972

DRIVE GEARING FOR ENGINE STARTERS

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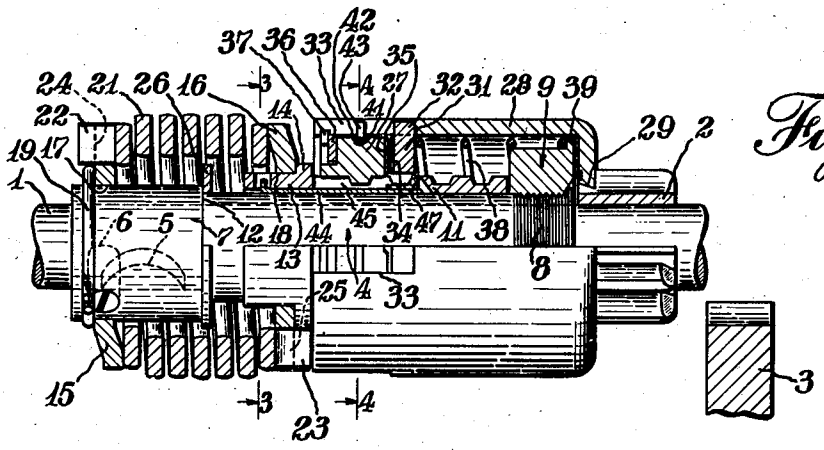


Fig. 1

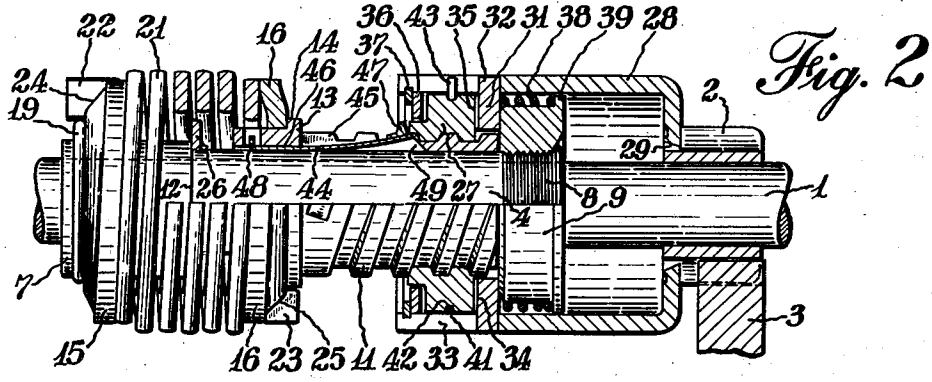


Fig. 2

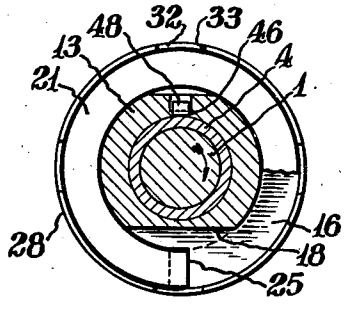


Fig. 3

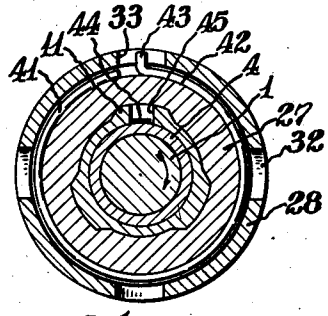


Fig. 4

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Fig. 5

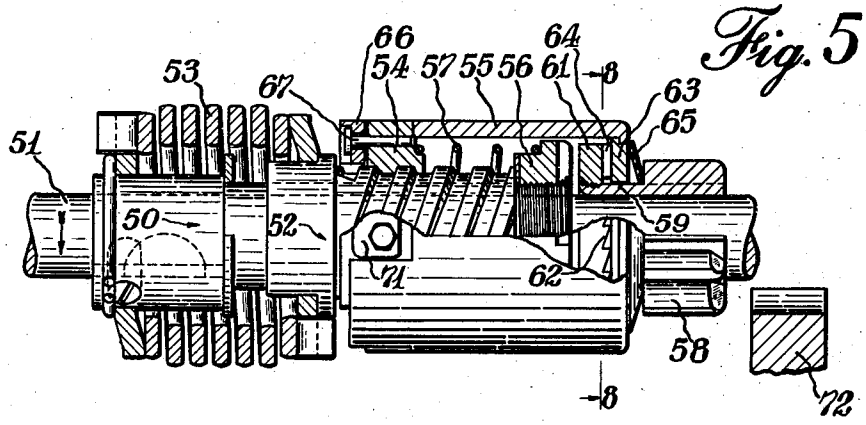
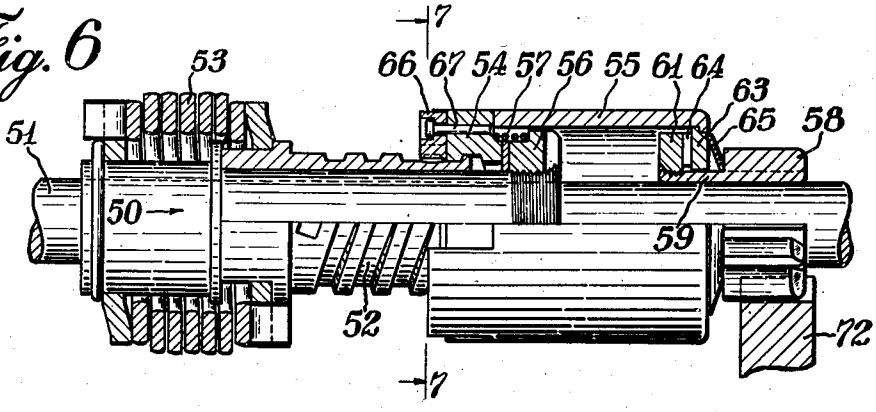


Fig. 6



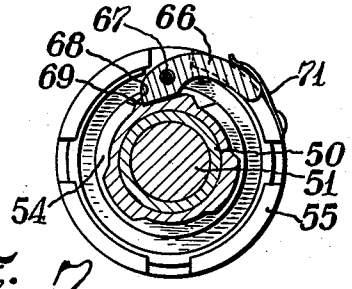


Fig. 7

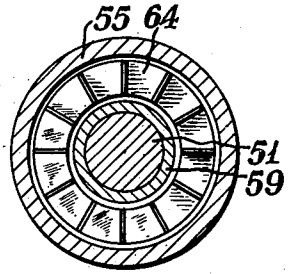


Fig. 8

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DRIVE GEARING FOR ENGINE STARTERS

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Application June 14, 1939, Serial No. 279,148

10 Claims. (Cl. 74—7)

The present invention relates to drive gearing for engine starters and more particularly to a starter drive, the engagement of which is controlled automatically by the energization of the starting motor.

In starter drives of the type in which energization of a starting motor causes the pinion to engage and crank a gear on the engine to be started, the pinion is usually returned immediately to its idle position by the overrunning of the engine gear when the engine starts. If then the engine should stall or stop for any reason, it is necessary for the starting motor to come substantially to rest and then be re-energized in order to secure re-engagement of the drive and resumption of the cranking operation.

It is an object of the present invention to provide a novel starter drive of the type in which the gearing is automatically engaged by acceleration of the starting motor, which is simple in construction and efficient and reliable in operation.

It is another object to provide such a device which is arranged to maintain the engagement of the gearing as long as the starting motor remains energized irrespective of whether or not the engine becomes self-operative.

It is a further object to provide such a device incorporating provisions for permitting the engine to overrun the drive without causing disengagement thereof.

It is another object to provide such a device which includes a self-tightening clutch connection between the starting motor and pinion.

It is another object to provide such a device in which the engagement of the drive is maintained by speed-responsive means rotatable with the starting motor.

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

Fig. 1 is a side elevation partly in section of a starter drive incorporating a preferred embodiment of the invention;

Fig. 2 is a similar view showing the parts in the positions assumed during the cranking operation;

Fig. 3 is a section taken substantially on the line 3—3 of Fig. 1;

Fig. 4 is a section taken substantially on the line 4—4 of Fig. 1;

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

Fig. 6 is a similar view showing the parts in driving position;

Fig. 7 is a section taken substantially on the line 7—7 of Fig. 6, showing the parts in locked position; and

Fig. 8 is a section taken substantially on the line 8—8 of Fig. 5.

In Fig. 1 of the drawings there is illustrated a power shaft 1 which may be the extended armature shaft of a starting motor, not illustrated. A pinion 2 is slidably journalled on the power shaft for longitudinal movement into and out of engagement with a member 3 such as a flywheel gear of an engine to be started.

A hollow sleeve 4 is fixed on the power shaft 1 by suitable means such as a key 5 and pin 6. Sleeve 4 is provided adjacent one end with an enlarged portion 7 having a non-circular or "double-D" cross section, the remainder of the sleeve being cylindrical and threaded at its opposite end as indicated at 8 for the reception of a stop nut 9.

A screw shaft 11 is slidably journalled on the sleeve 4 between the stop nut 9 and a shoulder 12 formed by the end of the enlarged portion 7 of the sleeve. Screw shaft 11 is provided with an enlarged head portion 13 of "double-D" cross section with a thrust shoulder 14 adjacent thereto. Driving and driven anchor members 15 and 16 in the form of discs or plates are provided with central openings 17 and 18 fitting the "double-D" enlargements 7 and 13 of the sleeve 4 and screw shaft 11 respectively. The driving anchor member 15 is confined on the enlargement or driving head 7 by means of a split lock ring 19, while the driven anchor member 16 bears against the shoulder 14 on the enlargement or driven head 13.

A yielding transmission member in the form of a spiral spring 21 is arranged to surround the driving and driven heads 7 and 13 and has outturned ends 22 and 23 entering axial slots 24 and 25 in the anchor members 15 and 16 respectively so as to yieldingly connect said members for rotation in unison while permitting longitudinal movement of the screw shaft 11 toward the driving head 7 until stopped by a thrust washer 26 seated against the shoulder 12.

Means responsive to acceleration of the power shaft 1 and consequently of the screw shaft 11 for moving the pinion 2 into operative engagement with the engine gear 3, is provided including a nut 27 threaded on the screw shaft, a barrel member 28 enclosing said nut and anchored as indicated at 29 to the pinion 2, and a clutch plate 31 in the barrel having peripheral lugs 32 slidably engaging in slots 33 in the barrel and having a clutch surface 34 arranged to cooperate with a clutch surface 35 on the nut 27. Means for confining

the nut 27 and clutch plate 31 in the barrel are provided in the form of thrust washer 36 and a split lock ring 37.

An anti-drift spring 38 located between a peripheral flange 39 on the stop nut 9 and the clutch plate 31 serves to normally maintain the parts in idle position. Frictional control means for the clutch nut 27 is provided in the form of a wire ring 41 seated in a groove 42 in the periphery of the nut and having an outturned end 43 engaging in a slot 33 of the barrel. Ring 41 is arranged to wrap down and grip the nut when the nut tends to overrun the barrel. Ring 41 also serves to transmit from the barrel to the nut a frictional rotative drag when the barrel overruns the nut.

According to the present invention, means are provided for holding the pinion in its operative position responsive to rotation of the power shaft above a predetermined speed. As here shown, this means is in the form of a centrifugal latch 44 mounted in a longitudinal slot 45 in the screw shaft and anchored at one end within the driven head 13 as indicated at 46. The free end of the latch is provided with a tooth or projection 47 which normally conforms to a portion of the thread on the screw shaft 11, but is movable by centrifugal force as shown in Fig. 2 to bring it into abutting relation with the rear surface of the clutch nut 27.

The end of the latch 44 is preferably turned out and anchored in a hole 48 in the sleeve in order to position the latch longitudinally with respect to the sleeve. The slot 45 preferably terminates in an inclined or stepped wall 49 which is arranged to engage the free end of the latch 44 and limit the outward movement of the latch to the position illustrated in Fig. 2.

In the operation of the invention, starting with the parts in the positions illustrated in Fig. 1, rotation of the power shaft 1 by the starting motor is transmitted through sleeve 4 and spring 21 to the screw shaft 11. Nut 27 is held from rotation by the control member 41 which is anchored in the barrel, whereby nut 27 is constrained to move longitudinally along the screw shaft, which motion is transmitted through the clutch plate 31 to the barrel 28 to move the pinion 2 into engagement with the engine gear 3. When the clutch plate 31 engages the stop nut 9, longitudinal movement thereof is arrested and the clutch nut 27 is caused to clamp the plate 31 against the stop nut and transmit rotation thereto.

When the engine starts, the acceleration of the engine gear 3 causes the pinion 2 and barrel 28 to overrun the screw shaft 11 whereby the nut 27 is backed away from the clutch plate 31, allowing the pinion, barrel and clutch plate to overrun.

If the engine continues self-operative, the overrunning of the barrel 28 causes a frictional drag through the spring ring 41 to be applied to the nut 27, tending to move it back to idle position. As long as the parts are rotating above a predetermined speed, however, the latch 44 is held out to its operative position as shown in Fig. 2, preventing backward motion of the nut 27 and holding the parts in operative position. If the engine should not continue to be self-operative, therefore, the starting motor will resume cranking the engine as soon as the engine slows down to a speed corresponding to the speed of the starting motor. This operation may be repeated indefinitely until a true start is secured and the engine remains self-operative. When this occurs, the operator causes the starting motor to be deenergized, whereupon the power shaft 1 and its associated parts slow down, and the latch 44 returns to idle position. Nut 27 is then traversed back to its idle position by the frictional effect of the spring ring 41, thus returning the pinion and barrel to their normal positions assisted by the anti-drift spring 38, in which positions these latter parts may continue to overrun until their rotary momentum is dissipated.

In Figs. 5 to 8 inclusive there is illustrated a second embodiment of the invention involving a re-location of the overrunning clutch, and a different form of centrifugal latch.

As here illustrated, a hollow sleeve 50 fixed to the power shaft 51 has freely journalled thereon a screw shaft 52 yieldably driven from the hollow shaft by a yielding driving connection including a spring 53 in the same manner as in the embodiment previously described. A control nut 54 is threaded on the screw shaft 52 and is rigidly connected in any suitable manner with a barrel member 55. A stop nut 56 fixed on the end of the hollow shaft 50 acts as an abutment both for the screw shaft 52 and the control nut 54. An anti-drift spring 57 normally maintains the control nut 54 in its idle position as illustrated in Fig. 1.

A pinion 58 is freely journalled on the power shaft 51 and is connected to the barrel 55 by means of an overrunning clutch which is arranged to provide for limited relative longitudinal movement. As here illustrated, the pinion 58 has an extended hub 59 to which is rigidly fixed a flange member 61 having ratchet teeth 62 formed on one side thereof. A cooperating clutch flange 63 is formed on or rigidly mounted in the end of the barrel 55 and is provided with ratchet teeth 64 arranged to cooperate with the teeth 62 of clutch flange 61. A spring 65 mounted on the hub of the pinion bearing against the end of the barrel yieldingly maintains the clutch teeth 62, 64 in engagement but permits them to overrun when the pinion is accelerated with respect to the barrel.

Centrifugal means for opposing traversal of the control nut 54 back to its idle position, are provided in the form of a latch member 66 (Fig 7) pivoted at 67 to the control nut 54 and having a nose 68 arranged to engage against a shoulder 69 formed in the periphery of the screw shaft 52. A spring 71 mounted on the barrel is provided for normally holding the latch out of engaging position, the latch being moved into engaging position, as illustrated in Fig. 7, by centrifugal force acting on the latch when the control nut and barrel are rotating above a predetermined speed.

In the operation of this embodiment of the invention, starting with the parts in the positions shown in Fig. 5, energization of the power shaft 51 causes rotation of the screw shaft 52 in the direction of the arrow whereby the control nut 54 is traversed into engagement with the stop nut 56, thus moving the pinion 58 into mesh with a member such as a flywheel gear 72 of an engine to be started. Torque is thereupon transmitted from the screw shaft through the barrel 55 and clutch connection 64, 62 to the pinion 58 to crank the engine.

When the engine starts, the acceleration of the engine gear 72 causes the pinion 58 to overrun the barrel 55 which is readily permitted by the overrunning clutch connection under the control of spring 65. Since at this time the screw shaft 52,

control nut 54 and barrel 55 are in rotation, the latch 66 is engaged against the shoulder 69 on the screw shaft and maintains the control nut 54 in its operative position as long as the power shaft 51 continues to be rotated by the starting motor.

When the operator opens the starting motor circuit, rotation of the power shaft, screw shaft, control nut and barrel ceases, whereupon the latch 66 is moved by the spring 71 into inoperative position, after which the control nut, barrel and pinion are permitted to be traversed back to idle position by the frictional drag of the rotating pinion through the overrunning clutch connection wth the barrel, assisted by the action of the anti-drift spring 57.

It will thus be seen that in this embodiment of the invention as in the embodiment first described, the starting pinion is maintained in mesh with the engine gear irrespective of overrunning thereof as long as the starting motor is energized, premature demeshing being positively prevented by the centrifugal latch 66.

It will be understood that the invention is not limited to the precise form of overrunning connection shown, since any suitable form of overrunning clutch may be used if it is arranged to engage and drive positively and to release without sticking.

Although but two embodiments of the invention have been shown and described in detail, it will be understood that other embodiments are possible and 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 combination with a power shaft, an engine starter drive mounted thereon including a pinion slidable on the power shaft into and out of engagement with a member of the engine to be started, means responsive to acceleration of the power shaft for moving the pinion into operative position, means including an overrunning clutch connection thereupon operative to rotate the pinion from the power shaft, said moving means being operative to return the pinion to idle position when the drive overruns the power shaft, and means responsive to the speed of rotation of the power shaft for holding the pinion in its operative position.

2. In combination with a power shaft, an engine starter drive mounted thereon including a pinion slidable on the power shaft into and out of engagement with a member of the engine to be started, means responsive to acceleration of the power shaft for moving the pinion into operative position, means including an overrunning clutch connection thereupon operative to rotate the pinion from the power shaft, said moving means being operative to return the pinion to idle position when the drive overruns the power shaft, and a detent member mounted to rotate substantially at the same speed as the power shaft, and movable by centrifugal force to engage an element of the pinion moving means and prevent return of the pinion to idle position.

3. In an engine starter drive, a motor shaft, a pinion movable thereon into and out of engagement with a member of an engine to be started, actuating means for the pinion including a screw shaft rotatable with the motor shaft, a nut threaded on the screw shaft, and a driving connection between the nut and pinion for transmitting longitudinal movement and rotation from the nut to the pinion, said driving connection including an overrunning clutch, and a centrifugal detent rotatable with the screw shaft adapted to hold the pinion in engagement with the engine member.

4. In an engine starter drive, a power shaft, a pinion slidable thereon into and out of engagement with a member of an engine to be started, means responsive to acceleration of the power shaft for moving the pinion into operative position and rotating the pinion, including a barrel member and an overrunning clutch between the barrel member and pinion, and centrifugal means rotatable with the barrel member for holding the pinion in operative position.

5. In an engine starter drive, a screw shaft, a nut threaded thereon, a pinion, means including a barrel rigidly connected to the nut for moving the pinion into and out of engagement with a member of an engine to be started, an overrunning clutch connection between the barrel and pinion, means limiting longitudinal movement of the nut in a direction to mesh the pinion, and means responsive to rotation of the nut for opposing return movement of the nut to idle position.

6. In an engine starter drive, a motor shaft, a pinion movable thereon into and out of engagement with a member of the engine to be started, actuating means for the pinion including a screw shaft rotatable with the motor shaft, a nut threaded on the screw shaft, a driving connection between the nut and pinion for transmitting longitudinal movement from the nut to the pinion including an overrunning clutch for rotating the pinion from the nut, means limiting longitudinal movement of the nut on the screw shaft in a direction to cause engagement of the pinion with the engine member, thereby causing rotation of the nut with the screw shaft, and means responsive to rotation of the screw shaft above a predetermined speed for preventing movement of the nut back to idle position.

7. In an engine starter drive, a motor shaft, a pinion, means responsive to acceleration of the motor shaft for moving the pinion into mesh with a member of an engine to be started including a self-tightening clutch, and a centrifugal detent rotatable with the motor shaft for holding the pinion in mesh with the engine member.

8. In an engine starter drive, a motor shaft, a pinion, means responsive to acceleration of the motor shaft for moving the pinion into mesh with a member of an engine to be started including a screw shaft, a nut threaded thereon, and a self-tightening friction clutch between the nut and pinion, frictional control means for the clutch arranged to transmit torque from the pinion to the nut when the pinion overruns the screw shaft, to thereby cause traversal of the pinion and nut back to idle position, and centrifugal means rotatable with the screw shaft for holding the pinion in mesh with the engine member while the screw shaft is rotating above a predetermined speed.

9. In an engine starter, a screw shaft, a pinion, means actuating the pinion from the screw shaft including a nut on the screw shaft, a barrel surrounding the nut connected to the pinion, a clutch plate non-rotatably mounted in the barrel engageable by the nut, and a stop limiting longitudinal movement of the clutch plate, a control clutch connecting the nut to the barrel opposing overrunning of the barrel by the pinion, and

a centrifugal detent mounted to rotate with the screw shaft, holding the nut and clutch plate adjacent the stop.

10. In an engine starter, a screw shaft, a pinion, means actuating the pinion from the screw shaft including a nut on the screw shaft, a barrel surrounding the nut connected to the pinion, a clutch plate non-rotatably mounted in the barrel engageable by the nut, a stop limiting longitudinal movement of the clutch plate, and an overrunning control clutch connecting the nut to the barrel arranged to grip and oppose overrunning of the barrel by the nut and also arranged to transmit torque frictionally from the barrel to the nut when the barrel overruns the nut, and a centrifugal detent rotatable with the screw shaft adapted to engage the nut and prevent it from overrunning the screw shaft when the screw shaft is rotating above a predetermined speed.

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