Aug. 10, 1948. J. E. BUXTON 2,446,808

ENGINE STARTER GEARING

Filed May 20, 1946 2 Sheets-Sheet 1

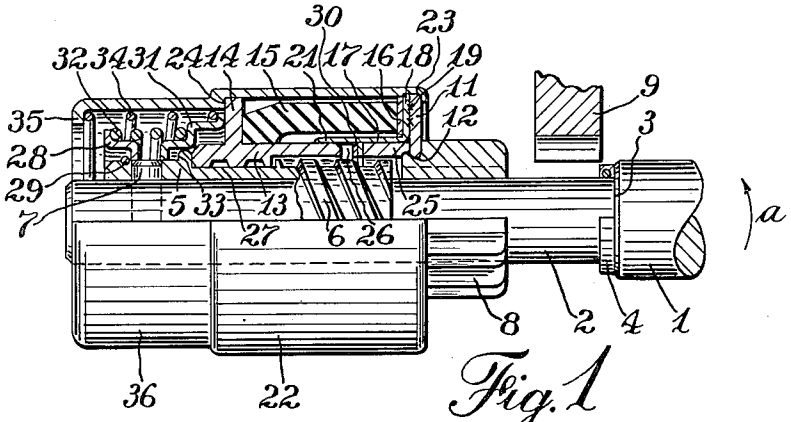


Fig. 1

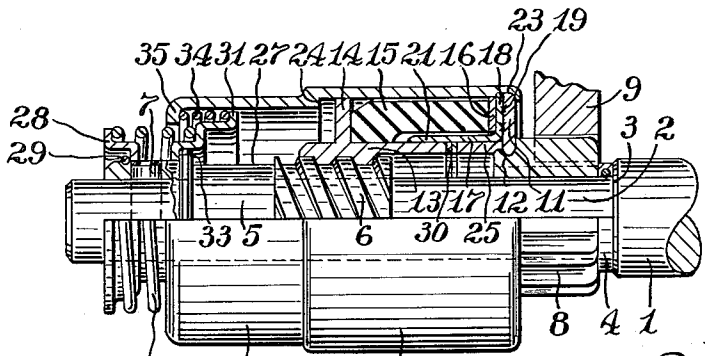


Fig. 2

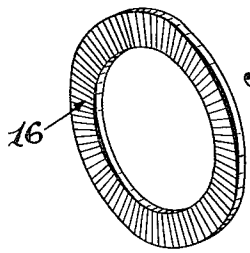


Fig. 3

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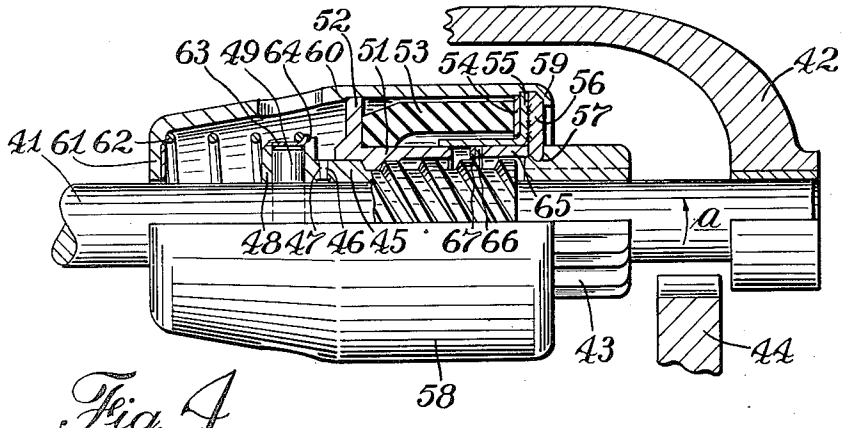


Fig. 1

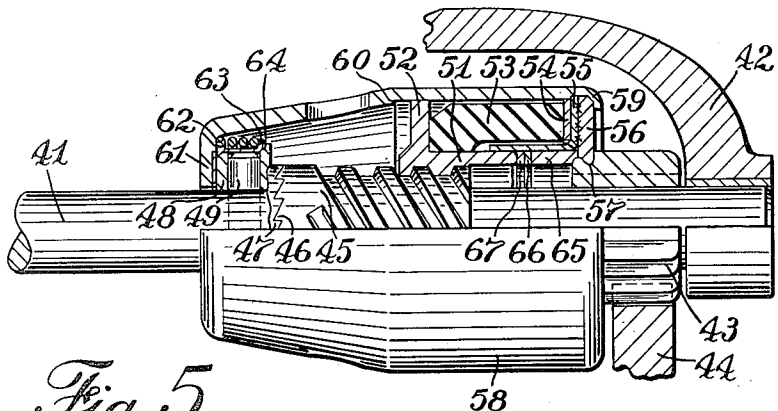


Fig. 5

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ENGINE STARTER GEARING

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6 Claims. (Cl. 74—7)

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The present invention relates to engine starter gearing and more particularly to a starter drive incorporating a friction clutch which is arranged to slip when a predetermined overload is applied thereto. This invention constitutes an improvement over the structure shown in applicant's prior Patent No. 2,319,441 which issued on May 18, 1943 to the assignee of the present application.

In those starter drives which employ a yielding element in the form of a member of elastically deformable material which is placed under compression by the operation of the drive, there is a tendency for the drive to stick when it is subjected to an overload such as may occur when the starter is energized at a time that the engine flywheel is rotating backward. Moreover, if the backward rotation of the flywheel is rapid, the shock of engagement of the drive may be destructive in spite of the cushioning effect of the elastically deformable material.

It is an object of the present invention to provide a novel engine starter drive having means for limiting the maximum torque transmitted therethrough.

It is another object to provide such a device incorporating a self-tightening friction clutch, and means for limiting the compression of the clutch so as to limit its torque capacity.

It is another object to provide a novel engine starter drive which is arranged to automatically disconnect and allow the starting pinion to overrun freely when the engine starts, with yielding means for holding the pinion in idle position, and yielding means for insuring traversal of the pinion into operative position when the starter is actuated, both said yielding means being so arranged as to avoid interference therebetween.

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 broken away and in section of a preferred embodiment of the invention, the parts being shown in overrunning position;

Fig. 2 is a similar view showing the parts in cranking position;

Fig. 3 is a detail in perspective of the clutch ring which transmits torque from the yielding member to the drive pinion.

Fig. 4 is a view similar to Fig. 1, of a second embodiment of the invention; and

Fig. 5 is a view similar to Fig. 4, showing the parts in cranking position.

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In Fig. 1 of the drawing there is illustrated a power shaft 1 having a smooth reduced extension 2 providing a shoulder 3 against which a thrust ring 4 is normally seated. A hollow shaft 5 which is threaded for a portion of its length as indicated at 6, is fixedly mounted on the free end of the power shaft 1 by suitable means such as a cross pin 7.

A drive pinion 8 is slidably journalled on the smooth portion 2 of the power shaft 1 for movement into and out of engagement with a member such as a gear 9 of the engine to be started, the operative position of the pinion being determined by its abutment with the thrust ring 4. The pinion has a flange 11 fixed thereto in any suitable manner as indicated at 12.

Means for actuating the pinion 8 from the screw shaft 5 is provided comprising a nut 13 on the screw shaft having a flange 14 forming a seat for a cylindrical block 15 of elastically deformable material such as rubber. A driving clutch member 16 is arranged to engage the end of the rubber block 15 so as to be rotated thereby. If deemed desirable the clutch member may be connected thereto by suitable means such as knurling as indicated in Fig. 3 so as to positively prevent relative rotation. A thimble 17 provided with a radial flange 18 forming a driven clutch element is fixed to the flange 11 of the pinion as by welding or brazing as indicated at 19. Said thimble has a longitudinally extending skirt 21 which fits slidably over the exterior of the control nut 13. A barrel member 22 is arranged to enclose the yielding member 15 and is attached to the flanges 18 and 11 of thimble 17 and pinion 8 respectively as shown at 23. The barrel 22 bears on the flange 14 of the control nut and has a shoulder 24 arranged to engage said flange and thereby hold the yielding member 15 normally under a slight compression.

Compression of the yielding member 15 forces the driving clutch member 16 into frictional engagement with the driven clutch flange 18 so as to transmit cranking torque to the drive pinion 8. Means for limiting the torque so transmitted to a predetermined maximum is provided in the form of a cylindrical stop member 25 interposed between the flange 11 of the pinion and the control nut 13 which arrests the longitudinal movement of the nut 13 after the space 26 therebetween has been taken up by compression of the member 15. Thrust washers 30 are preferably interposed between the nut 13 and stop member 25 to facilitate relative rotation. These washers may, if desired,

be of some self-lubricating material such as an oil-impregnated alloy.

The nut 13, when returned to its idle position runs off the ends of the threads 6 of the screw shaft as shown in Fig. 1, so that it may rotate freely on the smooth portion 27 of the screw shaft. Means for urging the nut into initial engagement with the threads 6 is provided comprising a thimble 28 slidably mounted on the end of the shaft 5 and retained thereon by means of a lock ring 29. A second thimble 31 is also slidably mounted on the end of the shaft 5, and a reentry spring 32 is seated on said thimbles and causes the thimble 31 to exert yielding pressure on flange 14 of the control nut. The longitudinal movement of thible 31 is limited by a shoulder 33 on the shaft 5 which accordingly defines the normal demeshed clearance between the pinion and the engine gear 9.

Means normally holding the pinion 8 in idle position against the thimble 31 is provided comprising an anti-drift spring 34 seated at one end on the thimble 31 and at its other end bearing against an inturned flange 35 on an extension 36 of the barrel member 22. It will be noted that since the anti-drift spring 34 bears on the thimble 31 which also serves as a seat for the reentry spring 32, the pressure of the anti-drift spring against the flange 35 of the barrel is not transmitted to reentry spring 32 but simply urges the flange 14 of the control nut against said thimble. Each of these two springs therefore performs its specialized function without opposition or interference by the other and may therefore be designed independently for optimum performance.

In the operation of the drive, starting with the parts in the positions illustrated in Fig. 1, rotation of the power shaft 1 in the direction of the arrow *a* by the starting motor, not illustrated, causes the control nut 13 to thread itself to the right along the screw shaft 5 until the pinion 8 engages the thrust ring 4. Further movement of the control nut is yieldably resisted by the rubber block 15, the compression of which forces the driving clutch member 16 into engagement with the driven clutch member 18 until sufficient torque is built up to cause the pinion 8 to rotate the engine gear 9.

When the engine starts, acceleration of the pinion 8 is transmitted back to the control nut 13 which accordingly threads itself back along the screw shaft 5 to idle position with the assistance of the anti-drift spring 34. Just before nut 13 runs off the ends of the threads 6, the flange 14 thereof encounters the thimble 31 thereby compressing the re-entry spring 32 which accordingly urges the nut into initial engagement with threads 6 after its momentum has been dissipated.

If the starter should inadvertently be energized at a time that the engine gear 9 is rotating backward, a collision between the forwardly rotating parts of the starter and the backwardly rotating parts of the engine occurs which may be so violent that the yielding member 15 is inadequate to prevent damage to the drive. In the present structure, such damage is prevented by limiting the torque capacity of the clutch 16, 18 by the cylindrical spacing member 25 which allows the member 15 to exert no more than a pre-determined maximum pressure on the clutch elements. Any loads which exceed the safe maximum for the drive, therefore, merely cause the clutch 16, 18 to slip and dissipate the kinetic energy of the rotating parts.

In Figs. 4 and 5 there is illustrated an embodiment of the invention in which the screw shaft is formed of two parts clutched together in order to allow the pinion and its associated parts to overrun the starting motor, and in which the anti-drift spring also serves to secure initial engagement of said clutch.

As there shown, a motor shaft 41 which may be the extended armature shaft of a motor not illustrated, is supported at its outer end in an outboard bearing 42 preferably provided by an extension of the motor frame. A pinion 43 is slidably mounted on the motor shaft for movement into and out of engagement with an engine gear 44. Means for actuating the pinion is provided comprising a screw shaft 45 slidably journalled on the motor shaft and having clutch teeth 46 adapted to engage similar clutch teeth 47 on a driving head 48 which is anchored to the shaft by a cross pin 49.

A control nut 51 having a radial flange 52 forms a seat for one end of an annular block 53 of elastically deformable material such as rubber, the opposite end of which bears against a driving clutch member in the form of a friction ring 54. A driven clutch member in the form of a thimble 55 is slidably mounted in telescopic relation with the nut 52 and is rigidly clamped at its outer end against a radial flange member 56 which is fixed to the pinion 43 in any suitable manner as indicated at 57. The thimble 55 and flange 56 are mounted in the end of a barrel member 58, and are clamped together by spinning over of the end of the barrel as shown at 59. The thimble and flange are preferably welded or brazed together as indicated.

Barrel 58 surrounds the rubber block 53 and has an internal shoulder 60 forming an abutment for the flange 52 of the control nut, which is so located as to maintain the rubber block 53 under initial compression. The barrel 58 extends rearwardly beyond the driving head 48 and has an inwardly directed flange 61 adapted to engage the driving head and thereby limit longitudinal movement of the pinion so as to define its meshed position.

Means for normally maintaining the pinion and barrel in idle position are provided in the form of an anti-drift spring 62 bearing at one end against the flange 61 of the barrel and at its other end seated on a flanged ring 63 which surrounds the driving head 48 so as to retain the pin 49 therein and seats against a shoulder 64 on said driving head. The backward movement of the pinion is preferably limited by engagement of the control nut 51 with the ends of the threads on the screw shaft 45.

In order to limit the transmission of torque to the pinion by limiting the compression of the friction clutch members 54, 55, positive spacing means are provided for limiting the compression of the rubber block 53. As here shown this means is in the form of a thrust ring 65 interposed between the flange 56 of the pinion and the adjacent end of the control nut 52.

It is desirable to reduce as far as practicable the transmission of torque from control nut 51 to the pinion flange 56 directly through the thrust ring 65 since the torque so transmitted is added to that transmitted through the friction clutch 54, 55 and to that extent reduces the effectiveness of the control of the load by said friction clutch. The small diameter of the thrust ring 65 reduces the torque transmitted therethrough to a minor value, and this is preferably still further reduced by the interposition of thrust rings 66, 67 which

may be of anti-friction material or even formed as a ball thrust bearing if so desired.

In the operation of this embodiment of the invention, starting with the parts in the positions illustrated in Fig. 4, energization of the motor causes rotation of the motor shaft 41 in the direction of the arrow *a* whereby the control nut 51 is moved to the right, traversing the pinion 43 and its associated parts until the flange 61 of the barrel engages the head 48 as shown in Fig. 5. Further rotation of the motor shaft causes the nut 51 to compress the rubber block 53 and transmit torque thereby through the friction clutch 54, 55 to the pinion to cause the pinion to rotate the engine gear.

Should the drive be actuated while the engine gear is rotating backwardly, collision of the forwardly rotating motor-actuated parts with the backwardly rotating engine gear causes the control nut 51 to move forward further, compressing the clutch 54, 55 until the nut engages the thrust ring 65. Thereupon the clutch members slip and so limit the stresses placed upon the parts of the drive to a safe value.

When the engine starts, the acceleration of the pinion 43 causes the nut 51 to be rotated faster than the screw shaft whereby the parts are returned to idle position, the excess speed of the barrel and associated parts causing the screw shaft to overrun the drive head 48 as permitted by the dental clutch 46, 47. These clutch teeth are preferably of the "saw-tooth" type as shown in order to facilitate the over-running action. When the parts come to rest the dental clutch 46, 47 is held in initial engagement by the anti-drift spring 62.

Although certain 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 claims appended hereto.

What is claimed is:

1. In an engine starter drive a power shaft, a pinion slidably journalled thereon for movement into and out of mesh with a gear of an engine to be started, means actuated by rotation of the power shaft for moving the pinion into mesh with the engine gear including a control member having an inclined connection with the power shaft, a driven friction clutch member fixed to the pinion, a driving clutch member cooperating therewith, and means including an elastic pressure and torque transmitting member connecting the control member to the driving clutch member for pressing the clutch members together and transmitting torque to the driving clutch member, and an anti-friction thrust bearing between the control member and pinion for limiting the pressure applied to the clutch members to thereby cause the clutch to slip when the drive is subjected to a predetermined overload.

2. An engine starter drive as set forth in claim 1 including further means for preventing slippage between the elastic member and the driving clutch member.

3. In an engine starter drive a power shaft, a pinion slidably journalled thereon for movement into and out of mesh with a gear of an engine to be started, an abutment on the shaft defining the meshed position of the pinion, a driven clutch member fixed to the pinion, a flanged control nut having a threaded connection with the shaft, a barrel member surrounding the control nut and driven clutch member, a driving clutch member loosely mounted in the barrel, an elastic pressure and torque transmitting member between the control nut and driving clutch member, and an annular anti-friction thrust bearing between the control nut and the driven clutch member for limiting the pressure of the elastic member on the driving clutch member.

4. In an engine starter drive a power shaft, a pinion slidably journalled thereon for movement into and out of mesh with a gear of an engine to be started, a hollow shaft threaded for a portion of its length, means connecting the hollow shaft to the power shaft for rotation therewith, a control nut on the hollow shaft having a yielding driving connection with the pinion, a barrel rigidly connected to the pinion and enclosing the nut and driving connection, an anti-drift spring connected between the hollow shaft and barrel urging the barrel and its associated parts toward idle position where the nut is on the unthreaded portion of the hollow shaft, a re-entry spring connected to the hollow shaft operative to move the control nut toward meshed position, and means for so limiting the expansion of said re-entry spring as to allow it to move the control nut into initial engagement with the threads of the hollow shaft.

5. An engine starter drive as set forth in claim 4 in which said hollow shaft has a thimble anchored thereon forming a seat for one end of the re-entry spring, and a second thimble slidably mounted on the hollow shaft having seats for both the anti-drift and re-entry springs, and formed to abut the control nut when in idle position.

6. In an engine starter drive a power shaft, a pinion movable thereon into and out of mesh with a gear of an engine to be started, means for actuating the pinion including a screw shaft connected to rotate with the power shaft, a control nut on the screw shaft, and means connecting the nut to the pinion, said nut being arranged to run off the threads of the screw shaft when the nut is returned to idle position; yielding re-entry means for urging the nut into initial engagement with the threads of the screw shaft, and yielding anti-drift means for urging the control nut into engagement with the re-entry means.

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