May 29, 1956 H. J. CROMWELL ET AL 2,747,414

STARTER

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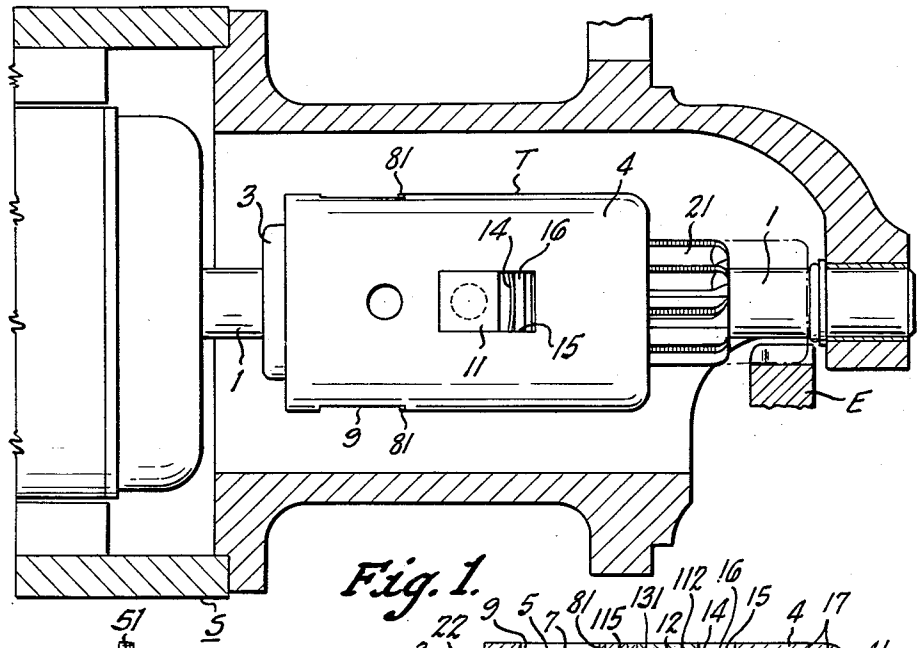


Fig. 1.

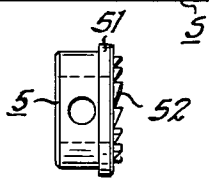


Fig. 5.

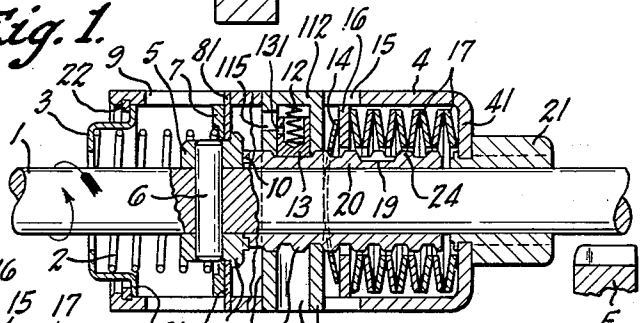


Fig. 2.

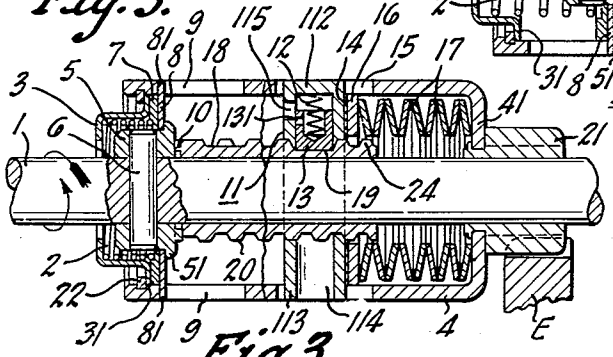


Fig. 3.

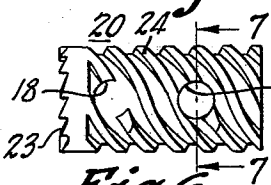


Fig. 6.

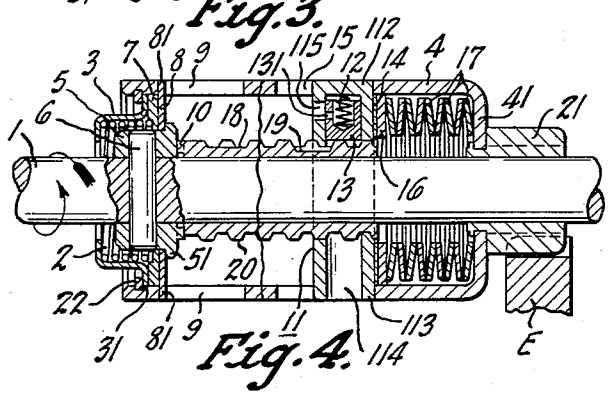


Fig. 4.

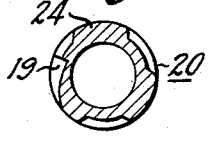


Fig. 7.

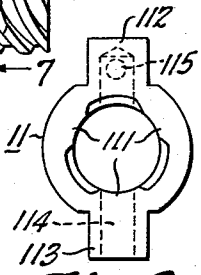


Fig. 8.

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STARTER

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4 Claims. (Cl. 74—7)

This invention relates to engine starter drives of the type wherein initial rotation of the starting motor shaft effects the meshing of a motor driven pinion with an engine flywheel gear and in which the pinion is automatically demeshed from the flywheel gear only upon the engine becoming self-operative.

One of the objects of the invention is to prevent demeshing of the pinion in case of a false start, thereby maintaining the meshing engagement between the pinion and flywheel, and thence eliminating the necessity for opening the starter switch and waiting for the starter motor to come to rest before repeating the starter operation.

This is accomplished by providing a driving collar on the starting motor shaft that has ratchet engagement with a screw sleeve traversed by a nut having driving relation with an enclosing casing that shifts and drives the pinion engageable with the flywheel gear. On initial rotation of the starting motor shaft the nut causes the housing to shift axially to mesh the pinion with the gear at which point a latch is engaged for restraining demeshing of the pinion and gear, yet permitting further travel of the nut on the screw to supply driving torque to the pinion and gear upon rotation of the starting motor.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a fragmentary, longitudinal, sectional view of a starting motor equipped with a starter drive or transmission embodying the present invention.

Fig. 2 is a longitudinal sectional view through the transmission with the parts shown in the rest position.

Fig. 3 is a similar view with the parts shown in a pinion engaging position.

Fig. 4 is a similar view with parts indicated in the cranking relation.

Fig. 5 is a detail of the driving collar.

Fig. 6 is a plan view of the screw shaft.

Fig. 7 is a transverse sectional view through the screw shaft, substantially as indicated by the line and arrows 7—7 of Fig. 6.

Fig. 8 is an elevational view of a driving nut.

Referring to the drawings in detail, a starting motor S is adapted to rotate a shaft 1 to drive an engine gear E, through the operation of a transmission T.

The transmission T includes a driving collar 5 mounted on the shaft 1 by means of a pin 6 as shown in Fig. 2. The driving collar 5 has a flange 51 against which is seated a washer 8 having diametrically opposed tongues or arms 81 receivable in slots 9 on a case 4. The washer 8, with its two projections 81 in the slots 9, will rotate upon the collar 5 with the case 4, and will still allow the case to move axially relatively to shaft 1. Against the washer 8 is disposed a washer 7 also rotatable on the collar 5 and within the case 4, so that it keeps the case 4 concentric with the collar 5, keeps the drive pin 6 in

place, and furnishes a seat for one end of a spring 2 that serves as a ratchet spring and continually urges the case 4 toward the left in demeshed relation. The other end of the spring 2 is seated in a cup 3 that surrounds shaft 1 and has a flange 31 engaged within the housing 4 where it is secured by a spring ring 22.

The collar 5 has a circular series of teeth 52 cooperable with a series of teeth 23 on a drive screw 20. These cooperative teeth provide a ratchet connection 10 between the drive collar 5 and the drive screw 20. The drive screw is free to rotate on drive shaft 1 except for the ratcheted connection 10, and is provided with high-lead screw threads 24 cooperable with matching threads 111 of a nut 11. The nut 11 has diametric extensions 112, 113 that are engageable within longitudinal slots 15 of the enclosing casing 4. A drill way 114 through the extension 113 and into the extension 112 provides for the assembly of a plunger 13 and spring 12 for cooperation with notches 18 and 19 in one of the threads 24 on the outside of drive screw 20. In the extension 112 a lateral bore 115 provides access to the plunger 13 for holding it radially outward for initial assembly of the nut and drive screw 20. A pin, key or other tool may be inserted into the opening 115 and into a notch or recess 131 of the plunger for withholding it until the nut is assembled on the screw.

The case 4 is connected rigidly with a pinion 21 that is rotatable upon the shaft 1, and the case 4 is in driving relation with the shaft 1 through the engagement of the drive collar 5, drive screw 20 and nut 11 which has its extensions 112 and 113 located in the slots 15 of the case. The case 4 also has a range of axial movement along the shaft 1 which is determined by the limits of the arm 81 in the slots 9, and the nut 11 has a range of axial movement with respect to the case 4 determined by the extensions 112, 113 in the slot 15. At the same time the nut 11 has a range of axial movement with respect to the drive screw 20 equal to the sum of the length of slots 9 and 15. Thus, the nut 11 may travel a greater distance axially than the case 4 can go.

When the case 4 moves axially to the right to the position permitted by the slots 9 and arms 81, the nut 11 will be disposed over the notch 19 of the sleeve 20, which is the pinion and gear meshing position, substantially as shown in Fig. 3. The housing 4 also encloses dished spring washers 17, known as Belleville washers, which are stacked between the end wall 41 of the case 4 and a plain washer 16 followed by spring washer 14 resting against the nut 11. The spring washer 14 acts as a pinion jump spring to assist in pinion and gear engagement if tooth abutments should occur, and also acts to prevent the Belleville washers from rattling. In the pinion and gear meshing position as shown in Fig. 3, the nut 11 will have traversed the threads of the screws 20 far enough for the plunger 13 to drop into the recess or notch 19. In that position the spring 2 will have been compressed and the flange 31 of the cap 3 will have abutted against the washer 7 stopping further axial movement of the case 4, which is also marked by the arms 81 of washer 8 engaging the left hand end of the slots 9. The nut 11 will have moved axially far enough to withdraw the extensions 112, and 113 from the left hand end of slots 15. The spring 14 will have been partially flattened out against the washer 16, thereby slightly increasing the compression of spring washers 17. Continued rotation of the shaft 1 causes further traverse of the nut 11 along the threads of the sleeve 20 until a position is reached somewhat as shown in Fig. 4, or the cranking position. In that position the torque is transmitted from nut 11 to casing 4 by extensions 112 and 113 acting on the sides of slots 15, for rotating the pinion 21 to drive the gear E.

When the armature of the starting motor is energized the shaft 1 accelerates rapidly and drives the screw 20 in a direction to thread to the left, through the nut 11. The nut 11 and the casing 4 at first tend to stand still without rotating movement, but move axially toward the right compressing the spring 2 until the meshing of the gear and pinion is accomplished. In the latter part of that axial movement some rotative movement of the case 4 may have begun, which will tend to relieve tooth abutment as the pinion 21 engages the gear E. Further traverse of the nut 11 along the threads of the screw 20 beyond the meshing positions results in rotative movement of the case 4, without any axial movement which is made possible because of the capacity of the pinion to rotate on the shaft 1 and of the washer 8 to rotate on the drive collar 5. During this further traverse of the nut 11 along the threads of the screw 20 the plunger 13 rides out of the notch 19 on top of the thread until the spring compacting position of Fig. 4 is reached. That is the cranking position.

When the engine starts, the nut 11 is screwed instantly to the left until the plunger 13 engages the notch 19 at the gear meshing position. The screw 20 will then rotate with the nut 11 and overrun or ratchet at the connection 10. That will continue until the speed with which the pinion is driven is sufficient to cause the plunger 13 to lift out of the notch 19, by centrifugal force. When the plunger is removed from the notch 19 the nut 11 is screwed to the left until the plunger engages the stop 18 or until the pinion strikes the right-hand end of screw 20. The spring 2 keeps the drive demeshed except during the starting operation.

The release of the lock by the action of centrifugal force on the plunger 13 in lifting it from the recess 19 is dependent upon the attainment of a certain speed of the nut 11 whether the nut is driven by the starting motor shaft 1 or by the pinion 21. The instant the engine becomes self-operative the spring washers 17 will be less compacted and eventually overrun at 10. When engine fires, torque is transmitted from the pinion 21 to the nut 11 which moves back to pinion meshing position over 19. Between the instant the engine fires and the instant the nut 11 obtains sufficient speed to effect retraction of the plunger 13, there is an appreciable lapse of time during which the nut 11 is rapidly accelerated by the starting motor, which has been relieved of engine cranking load, and which under normal conditions remains connected to the current source due to the failure of the car driver in promptly releasing the starter switch the instant the engine fires. As the nut 11 is accelerated by torque produced by the starting motor, assisted by the torque transmitted by the pinion 21, the speed of the drive screw 20 and nut 11 increases finally to a value such that centrifugal force acting on the plunger 13 overcomes the force of the spring 12, and the plunger 13 is lifted from the notch 19 so that the pinion 21 will be demeshed from the engine gear by virtue of engine operation. If it happens that the starter switch is opened before the speed of nut 11 reaches a value such that plunger 13 is lifted, said speed value will eventually be obtained by the torque transmitted from the pinion to the nut.

The release speed of the detent 13 is sufficiently high to prevent disengaging the pinion from the gear during irregular firing or false start of the engine, but that release speed is low enough to release instantly when the engine does start. During intermittent firing of the engine the nut 11 can move far enough to the left to engage the detent of the notch 19 which causes the screw 20 to rotate with nut and ratchet at 10 and keep the pinion and gear in mesh until the engine firing is satisfactory.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. An engine starter drive comprising a screw shaft connectible with a starting motor shaft, a toothed collar on the motor shaft for one-way drive of the screw shaft, a pinion movable axially along the motor shaft into mesh with an engine gear, a nut threadedly connected with the screw shaft, a casing secured to the pinion and enclosing the collar, screw shaft and nut, means within the casing for yieldingly transmitting motion axially between the nut and pinion, means for non-yieldingly transmitting rotary motion between the nut and pinion and means for positively latching the nut to the screw shaft when the nut has moved along the screw into a position for meshing of the pinion with the gear and releasable when the pinion is rotating at a predetermined speed, said means including a member of cylindrical form movable in response to centrifugal force in a direction normal to the axis of said screw shaft and away from said shaft in order to release the nut, a cylindrical recess in the peripheral surface of the screw shaft and engageable by said nut when in latching position, and a spring for holding the latching member in engagement with said recess until the pinion is rotated at a predetermined speed.

2. An engine starter drive comprising a screw-shaft connectible with a starting motor shaft, a toothed collar on the motor shaft for one-way drive of the screw-shaft, a pinion movable axially along the motor shaft into mesh with an engine gear, a nut threadedly connected with the screw-shaft, a casing secured to the pinion and enclosing the collar, screw-shaft and nut, means within the casing for yieldingly transmitting motion axially between the nut and pinion, said means comprising a plurality of Belleville washers compressible by axial movement of said nut toward the engine gear, means for non-yieldingly transmitting rotary motion between the nut and pinion and means for positively latching the nut to the screw-shaft when the nut has moved along the screw into a position for meshing of the pinion with the gear and releasable when the pinion is rotating at a predetermined speed, said means including a member responsive to the action of centrifugal force and adapted to engage a recess formed in the peripheral surface of the screw-shaft, and a spring for preventing disengagement of said member from said recess until a predetermined rotational speed of the pinion is attained.

3. An engine starter drive comprising a screw-shaft connectible with a starting motor shaft, a toothed collar on the motor shaft for one-way drive of the screw-shaft, a pinion movable axially along the motor shaft into mesh with an engine gear, a nut threadedly connected with the screw-shaft, a casing secured to the pinion and enclosing the collar, screw-shaft and nut, means within the casing for yieldingly transmitting motion axially between the nut and pinion, said means comprising a plurality of Belleville washers positioned in said casing between the nut and the pinion and compressible by axial movement of the nut when the pinion is moved into driving engagement with the engine gear, means for non-yieldingly transmitting rotary motion between the nut and pinion and means for positively latching the nut to the screw-shaft when the nut has moved along the screw into a position for meshing of the pinion with the gear and releasable when the pinion is rotating at a predetermined speed, said means including a member responsive to the action of centrifugal force and adapted to engage a recess formed in the peripheral surface of the screw-shaft, and a spring for preventing disengagement of said member from said recess until a predetermined rotational speed of the pinion is attained.

4. An engine starter drive comprising a screw-shaft connectible with a starting motor shaft, a toothed collar on the motor shaft for one-way drive of the screw-shaft, a pinion movable axially along the motor shaft into mesh with an engine gear, a nut threadedly connected with the screw-shaft, a casing secured to the pinion and enclosing the collar, screw-shaft and nut, means within the casing for yieldingly transmitting motion axially between

the nut and pinion, said means comprising a plurality of Belleville washers positioned in said casing between the nut and the pinion, an axially movable plate at one end of said group of washers and a spring element between said nut and plate compressible upon axial movement of the nut toward the pinion, means for non-yieldingly transmitting rotary motion between the nut and pinion and means for positively latching the nut to the screw-shaft when the nut has moved along the screw into a position for meshing of the pinion with the gear and releasable when the pinion is rotating at a predetermined speed, said means including a member responsive to the action of centrifugal force and adapted to engage a recess formed

in the peripheral surface of the screw-shaft, and a spring for preventing disengagement of said member from said recess until a predetermined rotational speed of the pinion is attained.

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