April 11, 1961 L. DANILEWICZ 2,979,048

STARTERS FOR INTERNAL COMBUSTION ENGINES

Filed June 19, 1959 3 Sheets-Sheet 1

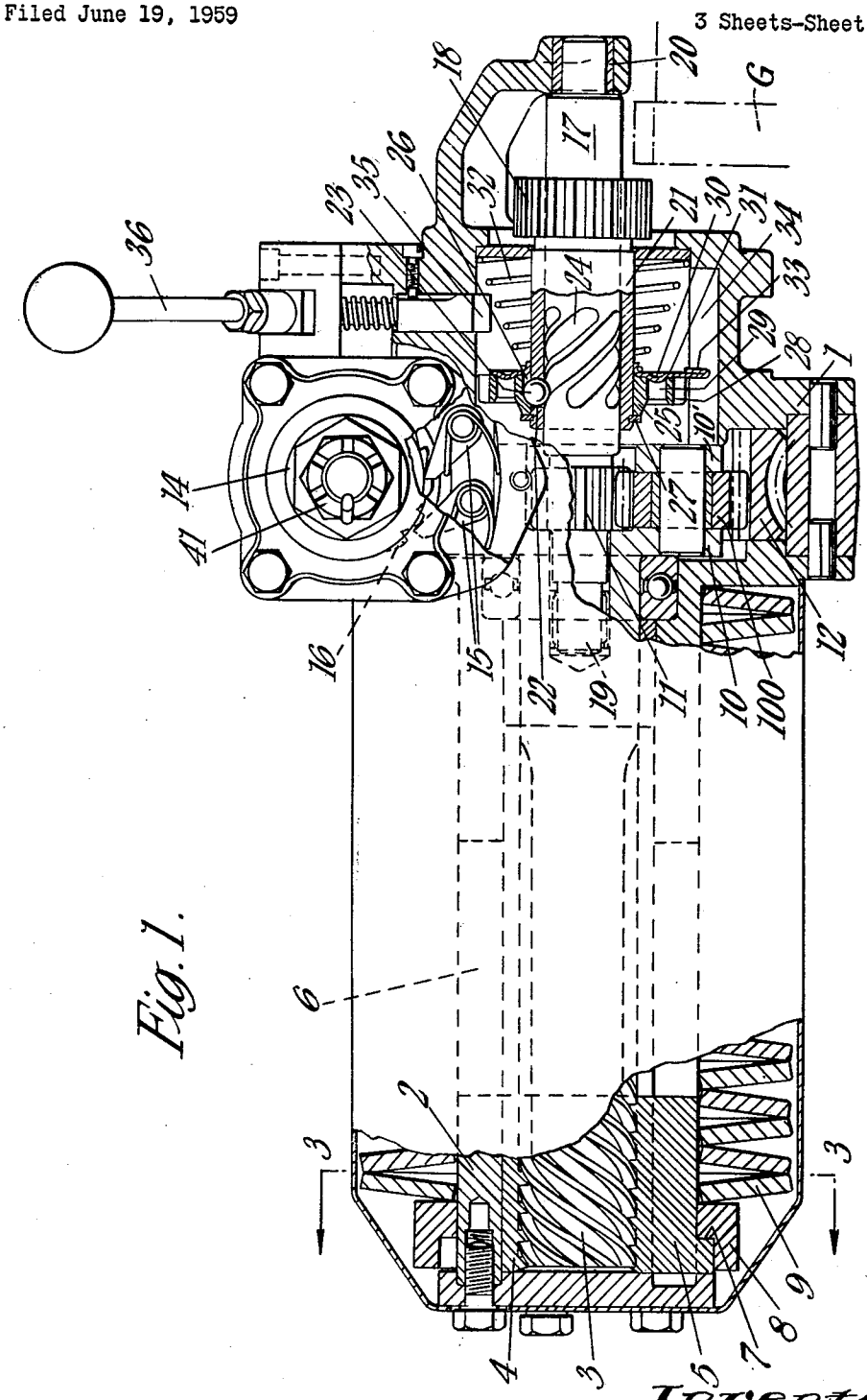


Fig. 1.

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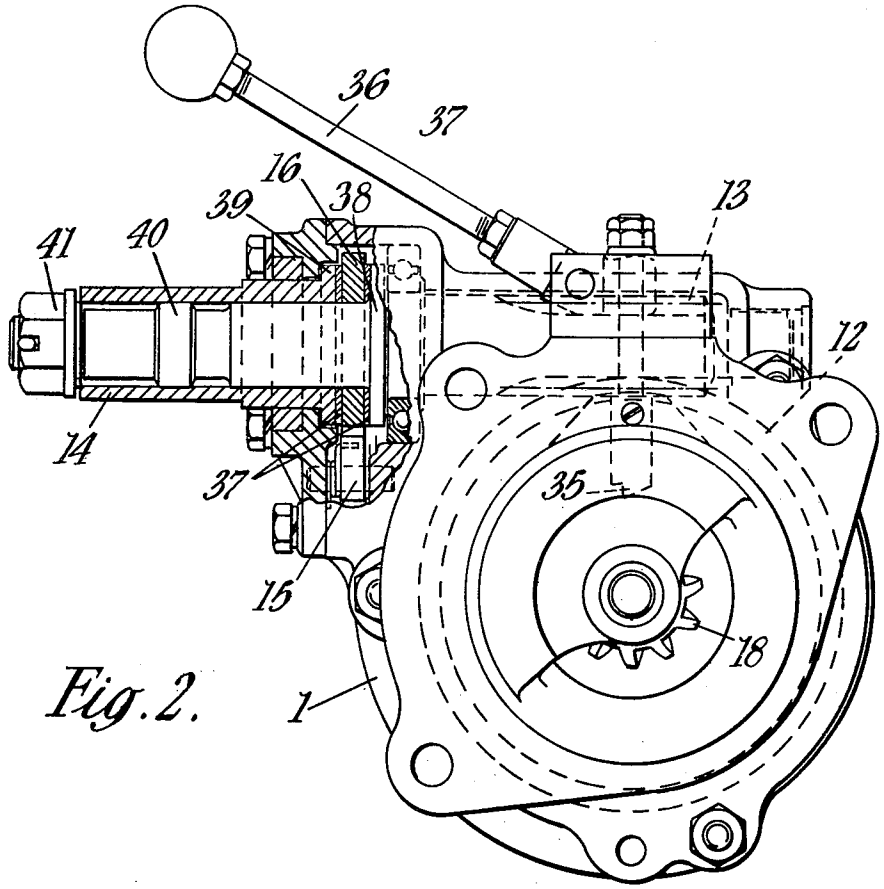


Fig. 2.

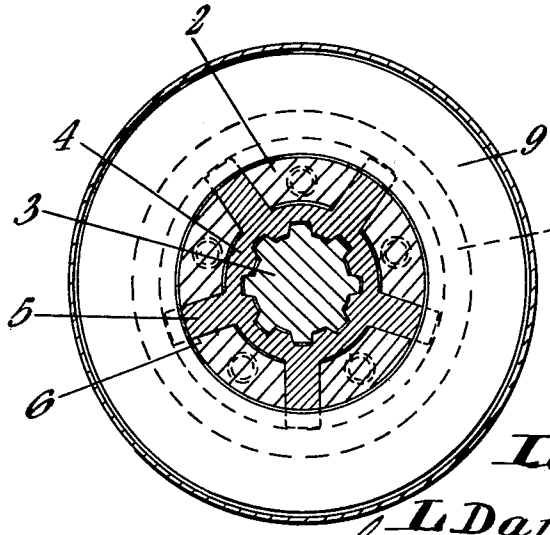


Fig. 3.

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STARTERS FOR INTERNAL COMBUSTION ENGINES

Filed June 19, 1959 3 Sheets-Sheet 3

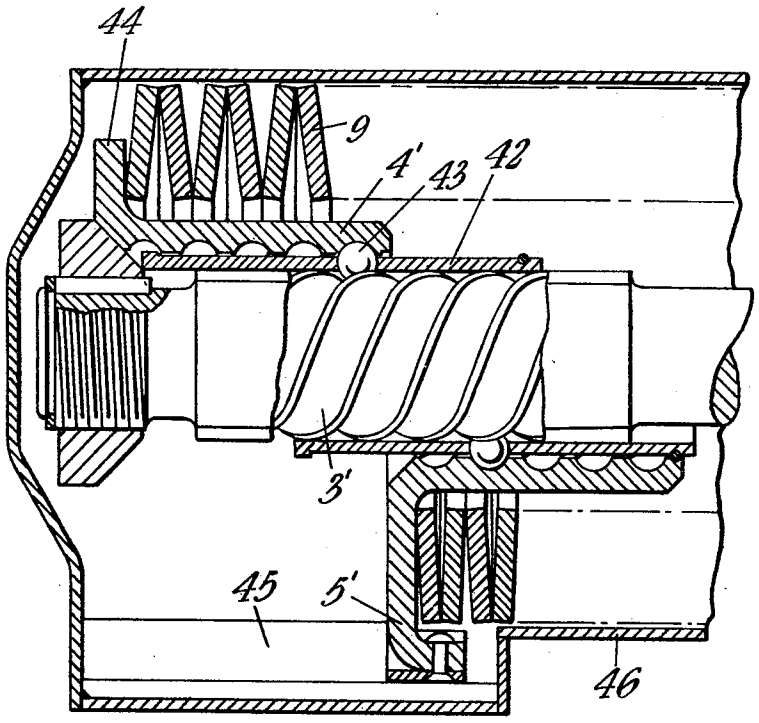


Fig. 4.

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STARTERS FOR INTERNAL COMBUSTION ENGINES

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7 Claims. (Cl. 123—179)

The present invention relates to improvements in starters for internal combustion engines.

More particularly, this invention relates to a starter arrangement for internal combustion engines of the type in which the starting effort is stored in a spring means and released when a start is to be effected, and including a starter pinion constructed and arranged to be advanced axially to an engine-engaging position by a helical screw mechanism and to be retracted by a helical screw mechanism when a start has been effected by the engine overrunning the starter.

Specifically, the invention relates to a starter arrangement of the type just described in which the spring means is energized through a suitable gear arrangement in response to turning movement of a handle.

It is an object of the present invention to provide a simplified drive transmission between a starter input shaft and the starter pinion combined with means to insure a satisfactory engagement of the starter pinion before the spring means is compressed to any substantial extent.

Specifically, the invention has for an object to provide a starter arrangement for internal combustion engines which includes a starter input shaft, a starter pinion, a helical screw mechanism operably associated with said starter pinion and adapted to advance such pinion to engine-engaging position, spring means adapted to be compressed to store up energy capable of turning the starter pinion to effect an engine start, and a differential arrangement including a sun gear means, planet carrier means, planet gear means carried by the planet carrier means and ring gear means, all said gear means being in operative interengaging relationship, one of said means being connected to the starter input shaft, another of said means being operably coupled to the spring means, and a third of said means being operably coupled to the starter pinion.

It is a more specific object of the invention to incorporate in the starter arrangement a catch means adapted to cooperate with the starter pinion to constrain the same against rotation sufficiently to cause the starter pinion to be moved into engine-engaging position by the helical screw mechanism when a drive is first imparted to said mechanism.

It is a further specific object to provide a starter arrangement for internal combustion engines of the type heretofore described which further includes a retractable detent means adapted to lock the starter pinion when a drive impulse is to be employed to energize the spring means. Specifically, this retractable detent is mounted in a position to be engaged automatically when the starter pinion has moved to engine-engaging position.

It is a still more specific object of the invention to provide a starter arrangement including an input drive means including a worm shaft adapted to be turned by a handle, a starter pinion mounted for axial movement between engine-engaging and engine-disengaging positions, a helical screw mechanism operably associated with said starter pinion and adapted to cause the same to move

axially, a spring means, means for compressing the spring means to store energy sufficient to cause the starter pinion to start an engine, and a differential gear arrangement including a ring gear having its outer surface shaped to constitute a worm wheel, a planet carrier means, planet gear means carried by the planet carrier means and in meshing relationship with the ring gear, means coupling the planet carrier means to the spring means to compress the same, and a sun gear means in meshing engagement with the planet gear means and operably coupled to the starter pinion.

Still more specifically, the invention provides an arrangement in which the coupling between the planet carrier and the spring means comprises a shaft secured to the carrier, said shaft having an axial bore therein, and a shaft carrying the sun gear means journaled in said bore.

It is a still more particular object of the invention to provide the spring means in the form of a stack of spring discs and to operably associate a coaxial reversible helical screw mechanism at one end of the stack of spring discs adapted to be driven in response to turning movement of the input shaft to compress the stack of spring discs. Specifically, the helical screw mechanism comprises an externally threaded shaft, an internally threaded nut in engagement with the threads on the shaft and which nut includes a radially extending component guided for axial movement so as to restrain the nut against rotation and cause the same to transmit axial thrust to the spring discs to compress the same.

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

Figure 1 is a side view partly in elevation and partly in section and illustrating an engine starter of the present invention,

Figure 2 is an end view partly in elevation and partly in section of the arrangement of Figure 1 as viewed from the right,

Figure 3 is a cross sectional view taken on line 3—3 of Figure 1, and

Figure 4 is a fragmentary longitudinal sectional view with some parts in elevation, illustrating a modified form of the helical screw mechanism that is coupled with the spring discs for compressing the same.

The starter arrangement illustrated in Figures 1 to 3 includes a casing or body portion 1 from one end of which projects a sleeve 2. Coaxially mounted within this sleeve is a screw and nut arrangement including an internally threaded nut 4 in sliding fit within the sleeve and having its threads engaged with the external helical threads on an externally threaded shaft 3. The nut 4 includes radially extending projections 5 passing through slots 6 arranged in the sleeve 2. The projections 5 include an abutment face or shoulder 7 bearing against the base of a cup washer 8, the end face of which bears against and constitutes an abutment for a stack of annular spring discs 9 that are mounted about the sleeve 2. The other end of the stack of spring discs bears against the left hand end face of the casing or body portion 1. The engagement of the radial projections 5 in the slots 6 constrains the nut against rotation, whereby rotation of shaft or screw 3 in one direction will compress the springs 9 the left hand end face of body portion 1 and by reaction, that is, expansion of the stack of spring discs, the force generated during expansion will exert a driving force on shaft 3.

The inner end of shaft 3 is disposed within body portion 1 and includes an annular flange 10 that constitutes part of a planet carrier means of a differential gear. An annulus 10' is suitably apertured to receive the pins that support the planet gear means 100 carried by the carrier,

The right hand end of the shaft 3 is provided with a bore that accommodates a portion of a drivng or output shaft 17 journaled at 19 in that bore. Fixed to shaft 17 is a sun gear 11 that is in mesh with the planet gear means 100. The differential further includes a ring gear 12 in engagement with the planet gear means 100. The outer periphery of this ring gear 12 is shaped to define a worm gear adapted to cooperate with a worm 13, Figure 2, coupled with a starter input shaft 14 adapted to be engaged by a driving handle, not shown, and controlled by pawls 15 and a ratchet wheel 16.

A starter pinion 18 is secured to a sleeve 21 disposed around shaft 17 between the sun gear 11 and the right hand end of that shaft which is journaled at 20 to a portion of the casing or body structure 1. Sleeve 21 is provided with a plurality of drilled holes 22 which accommodate balls 23 engaged in inclined or part helical grooves 24 cut in the periphery of shaft 17. This groove relationship constitutes what is known as a multi-start helical groove. The balls 23 are held in place by a collar 25 formed with axially extending grooves 26 corresponding in number to the number of balls, each of which accommodates a ball to prevent the collar from turning relative to the sleeve 21. The collar is located by a C-clip 27 and has its periphery shaped to define gear teeth, so that the collar constitutes a spur wheel or pinion 28. The collar is further provided with axial holes 29, the inner peripheries of which cooperate with projections 30 formed by indenting a disc 31. The disc is backed up by a spring 32 that is biased against an annular member fitting in the right hand portion of the casing or body 1. The disc 31 includes a radially extending finger or projection 33 that is engaged in an axially extending groove or channel 34 provided on the interior of the right hand part of body portion 1 so as to constrain the disc 31 from rotating. The disc functions as a click stop. The aforedescribed arrangement permits axial movement of the sleeve 21 and starter pinion 18, and between the illustrated retracted position of the pinion or spur gear 28 and the right hand end of the casing is mounted a spring loaded detent 35, the end of which is projected into position to mesh with the teeth on spur gear 28 when it and the sleeve have been moved to the right to what is termed a forward position. A handle 36 is operably connected with the shaft of the detent 35 to retract the same.

In operation of the aforedescribed arrangement, the tubular shaft 14 is turned by a handle, not shown, thus through the worm 13 imparting rotation to the annulus or ring gear 12. This turns the sun gear 11 and with it shaft 17, due to the relatively great resistance offered by shaft 3 and the attached planet carrier 10. The click stop disc 31 restrains sleeve 21 against rotation so that this sleeve and starter pinion 18 are moved to the right by the cooperation of the helical grooves 24 with the balls 23 until the balls reach the right hand end of the grooves 24. At this position the teeth of pinion 28 are engaged by the detent 35 so as to lock the sun wheel. Likewise, starter pinion 18 is engaged with the gear G of the engine to be started. The engagement between the detent 35 and the pinion 28 can be effected by leaving the detent down. When the sun gear 11 is locked by the engagement of the detent with the pinion 28 the drive from shaft 14 is taken off through the planet carrier 10 to shaft 3 so as to move the nut 4 to the right to compress the spring discs 9. When a start is to be effected, springs 9 being compressed and the starter pinion being in engagement with gear G, it is only necessary to actuate handle 36 to lift the detent 35 out of engagement with the pinion 28 and the energy stored in the spring discs 9 will move the nut 4 to the left causing shaft 3 to turn and through the differential drive the starter pinion. To permit the springs 9 to be unstressed when desired without turning pinion 18, a friction clutch is interposed between the tubular shaft 14, the worm shaft 13 and ratchet wheel 16. This clutch includes friction rings 37, one of which is interposed between the ratchet wheel 16 and a shoulder 38 provided on the worm shaft 13, the other disc being interposed between the opposite face of ratchet wheel 16 and a flange 39 on the inner end of the tubular shaft 14. The worm shaft 13 includes an extension 40 fitting within shaft 14 and screwed up by a nut 41 so as to tighten the clutch.

Figure 4 discloses an alternative form of helical screw mechanism for cooperation with the spring discs. In this form of the invention, a loose sleeve 42 is provided with a plurality of apertures adapted to house balls 43 that are engaged in the grooves forming the helical threads on shaft 3'. A nut 4' is provided with a flange 44 serving as an abutment for one end of the stack of spring discs 9. A radially extending portion of the flange 44 defines a finger or projection 5' that engages in a longitudinal guideway 45 provided in a shell or casing 46 mounted over the spring discs 9. This engagement constrains the nut 4' against rotation and forces it to move axially to compress the discs. Further, the balls 43 are able to describe an appropriate rolling motion as shaft 3 is turned.

While the spring means illustrated and described preferably consists of a stack of disc spring members, the invention is not to be restricted to this type of springs. For example, the spring means can consist of torsion springs, either helical or spiral, or of the straight bar type, or helical tension or compression springs could be utilized made of rubber, plastic or metal.

What is claimed is:

1. A starter for an internal combustion engine including a starter drive input means, a spring means adapted to be energized to store up a starting effort that can be released when a start is to be effected, a starter pinion, a helical screw mechanism to move said pinion axially between a retracted position and an advanced engine-engaging position, and a differential gear including at least three components, one of said components being connected to said starter drive input means, another of said components being operably coupled to the spring means, and the third component being operably coupled with the starter pinion.

2. A starter as claimed in claim 1, and further including a retractable detent for locking said starter pinion, said detent being disposed between the retracted and advanced position of the starter pinion and mounted for movement between an operative locking position and a retracted inoperative position, and means movable with the starter pinion adapted to automatically engage the detent when it is in the locking position so as to lock the starter pinion as said pinion completes its advance, during the first stage of a starting operation.

3. A starter as claimed in claim 1, in which the differential component connected with the starter drive input means comprises a ring gear having its outer periphery shaped to constitute a worm wheel and said starter drive input means including a worm shaft in meshing engagement with said worm wheel.

4. A starter as claimed in claim 1, and said spring means comprising a stack of compressible spring discs and a helical screw mechanism for compressing said discs.

5. A starter as claimed in claim 1, and further including a starter output shaft, said helical screw mechanism for moving said starter pinion including a sleeve connected to said starter pinion, surrounding said output shaft and having radial holes therein, said output shaft having a plurality of part helical grooves therein defining a multi-start helical groove relationship, and balls engaged in said grooves and holes.

6. A starter arrangement for internal combustion engines including a starter input shaft means, an output shaft means, a starter pinion, means including a helical screw mechanism interengaging said output shaft means and said starter pinion for moving said pinion axially of said output shaft means between a retracted position and

an advanced engine-engaging position and for turning said starter pinion to effect a start when in such advanced position, spring means adapted to be compressed to store up energy sufficient to turn the starter pinion to effect an engine starting operation, turnable means for compressing said spring means, and a differential gear arrangement including a sun gear means carried by said output shaft means, planet gear means carried by the turnable means for compressing the spring means and ring gear means, all said gear means being in operative interengaging relationship, and said ring gear means being connected to said starter input shaft means whereby turning of the latter initially effects advancing movement of the starter pinion to engine-engaging position and thereafter compresses said spring means for storing up energy capable of effecting a starting operation.

7. A starter arrangement for internal combustion engines including a starter input shaft means, an output shaft means, a starter pinion, means including a helical screw mechanism interengaging said output shaft means and said starter pinion for moving said pinion axially of said output shaft means between a retracted position and an advanced engine-engaging position and for turning said starter pinion to effect a start when in such advanced position, spring means adapted to be compressed to store up energy sufficient to turn the starter pinion to effect an engine starting operation, turnable means for compressing said spring means, and a differential gear arrangement including a sun gear means carried by said output shaft means, planet gear means carried by the turnable means for compressing the spring means and ring gear means, all said gear means being in operative interengaging relationship, said ring gear means being connected to said starter input shaft means whereby turning of the latter initially effects advancing movement of the starter pinion to engine-engaging position and thereafter compresses said spring means for storing up energy capable of effecting a starting operation, latching means operably associated with said helical screw mechanism for constraining the same against rotation sufficiently to cause the starter pinion to be moved to engine-engaging position when a drive is first imparted to said input shaft means, releasable starter locking means adapted to lock said starter pinion against rotation after it has moved to engine-engaging position so as to cause further turning of said input shaft means to compress said spring means, and means for releasing said locking means when a start is to be effected.

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