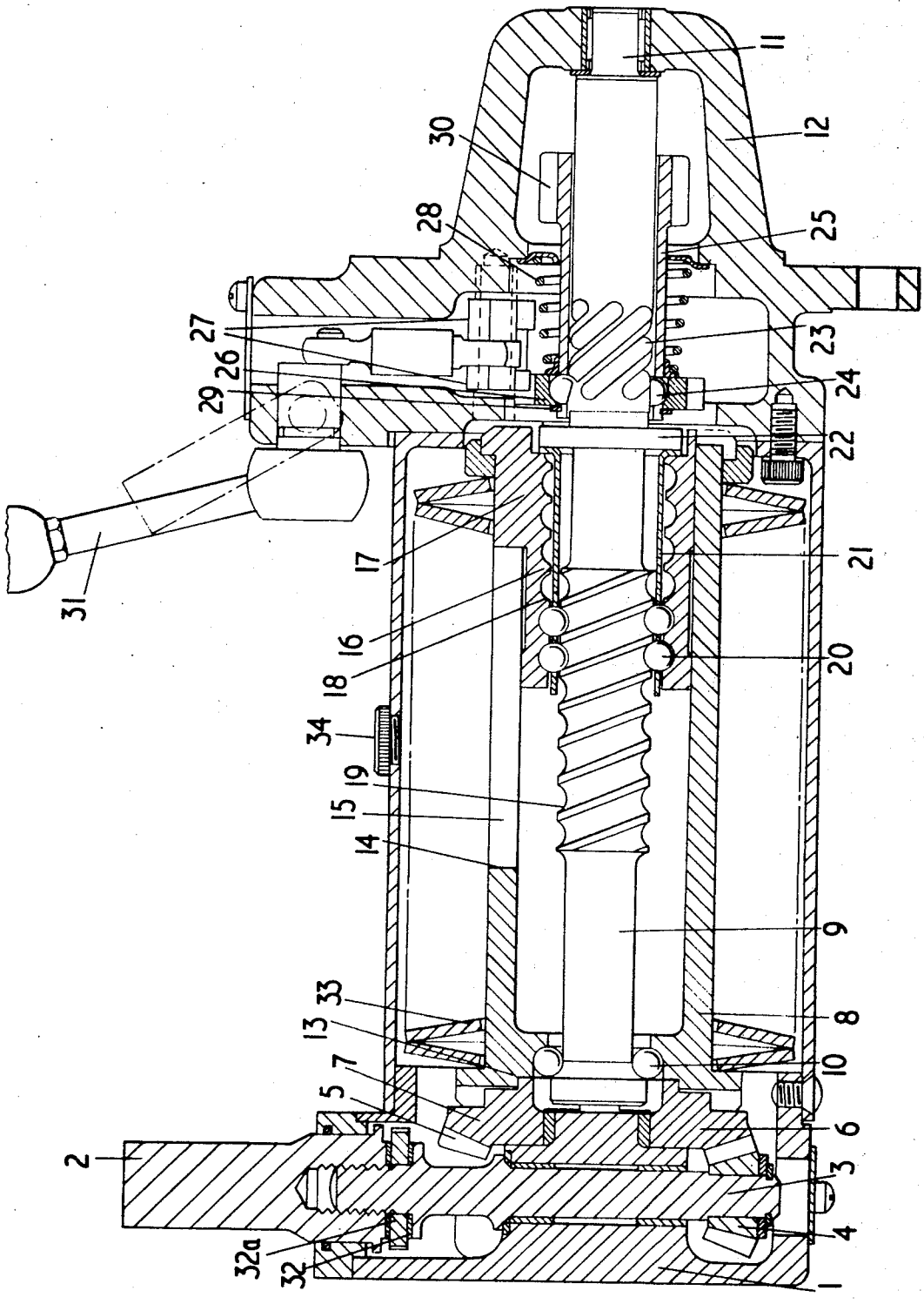
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STARTERS FOR INTERNAL COMBUSTION ENGINES

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STARTERS FOR INTERNAL COMBUSTION ENGINES

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ABSTRACT OF THE DISCLOSURE

In a spring starter providing for moving the starter pinion into engagement in the first stage of winding the spring up, the need for a differential gear is avoided by rotatably mounting the spring assembly on the starter shaft for rotation relative to the starter as a whole.

The present invention relates to improvements in starters for internal combustion engines of the kind in which the starting effort is stored in a spring and released when a start is to be effected.

In starter of this kind it has already been proposed to provide a shaft on which is mounted a starter pinion for engagement with a flywheel of an internal combustion engine and a further shaft on which are mounted springs in which the starting effort is stored. During the starting operation the starter pinion is moved on the first mentioned shaft and then the springs are compressed on the second mentioned shaft. A differential gear is required between the two shafts to provide for the different stages of transmission.

It is an object of the present invention to enable the construction of starters of this kind to be simplified.

According to the present invention a starter of the kind referred to comprises a main shaft on a first portion of which there is mounted a starter pinion and on a second portion of which there is mounted a spring assembly arranged for storing the starting effort with a drive arrangement for imparting starting effort to the spring assembly positioned at or towards an end of the main shaft.

To permit this simplified arrangement, it is an essential feature of the invention that the spring assembly be rotatable relative to the second portion of the main shaft. This permits the spring to be compressed by means of a drive arrangement, without rotation of the main shaft.

The drive arrangement may be rotated about an axis which is perpendicular to the axis of the main shaft with a bevel gear coupling between the drive arrangement and spring assembly.

Alternatively, the drive arrangement may be rotated coaxially with the main shaft with a direct drive coupling the drive arrangement to the spring assembly.

In a further alternative, the drive arrangement may be rotated about an axis which is disposed parallel to the axis of the main shaft with a spur gear coupling the drive arrangement and spring assembly.

The second portion of the main shaft may be mounted within a coaxially disposed sleeve member forming part of the spring assembly which is arranged for rotation with respect to the starter housing in application of starting effort to the starter. The starter spring or spring stack will then be mounted on the sleeve member, and arranged for compression by a nut, also forming part of the spring assembly, reversibly screwing on the second portion of the main shaft.

Bearing balls may be disposed in grooves in the second portion of the main shaft as transmission means between the latter and the aforesaid nut. This nut by being splined to the aforesaid sleeve member will move axially upon rotation of the spring assembly when the main shaft is held against rotation. At the other end of the main shaft, i.e. in the first portion thereof, a sleeve carrying the starter pinion may be mounted as a nut for relative screwing motion. Here again bearing balls may be used as transmission means between the main shaft and the sleeve. In one convenient arrangement, the balls are housed in apertures in the sleeve and located by an encircling ratchet member to engage with a pawl member which is spring loaded for avoiding rotation of the sleeve but enabling some degree of rotation of the starter pinion to take place on the starter pinion teeth not being in mesh with the teeth of the flywheel of an engine to be started. Release of the pawl member engaging with the ratchet may be obtained through a manually operated lever.

It may be arranged that the disposition of the spring or spring stack on the sleeve member forming part of the spring assembly is viewable through a sighting aperture provided in the starter housing.

The driving arrangement for imparting starting effort to the starter may comprise a friction operated cranking device to enable slow release of the stored energy by turning the handle in the reverse, unwinding direction.

Reference is now made to the accompanying drawing which illustrates in longitudinal section an embodiment of the present invention here given by way of example.

The starter illustrated has a housing **1** with a starting handle attachment **2** coupling on to a rotatable spindle **3** provided at the lower end thereof with a driving bevel gear **4**. The bevel gear **4** meshes with a bevel gear **5** formed on the end face of a cylindrical collar member **6** meshing through dogs **7** at its other end face with grooves in the adjacent end of a sleeve member **8**. Mounted coaxially within the sleeve member **8** is a main shaft **9**, with the shaft extending as one piece from its ball mounting **10** at its left hand end (second portion) right through to a right hand cylindrical end **11** of the shaft bearing, which is in a cap member **12** in the form of a nosepiece.

The sleeve member **8** extends from its left hand end face indicated at **13** with an unapertured wall up to the axial extent indicated by the surface at **14** and for the remainder of its axial extent has four longitudinal slots, of which one is indicated at **15**, formed therein. A nut **16** fits into the right hand end of sleeve member **8** and the nut **16** is provided with four longitudinal protuberances of which one is indicated at **17**, with the protuberances **17** keying into the slots **15**. The nut can thereby move from the right hand of sleeve member **8** to the left, as hereinafter described. The nut **16** has an internal spiral groove **18** cooperating with a spiral groove **19** in the shaft **9**. Bearing balls **20**, which are located between the groove **19** and cooperating groove **18** and housed in a cage **21**, serve to transmit driving forces between the main shaft **9** and the nut **16**.

The nut **16** and cage **21**, in the resting position illustrated, abut at the right hand parts thereof against a collar or shoulder **22** on the shaft **9**. On the further right hand part of the shaft **9** beyond the collar **22**, that is, the "first" part of the main shaft, there is a multi-start helical groove **23** in which are disposed bearing balls **24** located in circumferentially spaced holes in a sleeve **25**. Enclosing and retaining the bearing balls **24** is a ratchet member **26** interengaging with a pawl **27** in the form of a fork with two limbs, with the left hand limb initially engaging the ratchet member **26** and the right

hand limb engaging the ratchet member **26** when the sleeve **25** and ratchet member **26** have moved to the right along the shaft **9** as hereinafter described. A spring **28** urges the ratchet member **26** to the left and consequently the whole pinion assembly is urged to the left a circlip **29** in a circular groove in the sleeve **25** serves to locate the ratchet member **26** in position on the shaft **9** with the ratchet member moving in unison with the sleeve **25**. A starter pinion **30** at the end part of the sleeve **25** is for meshing with and turning the flywheel of an engine to be started. Manual depression of a lever **31** causes the pawl **27** to come out of engagement with the ratchet member **26**, with the ratchet member **26** and starter pinion **30** then being free to rotate with the shaft **9**. A guard strap indicated in dot and dash lines can be placed in position to prevent accidental depression of the lever **31**.

A main starter spring **33** consisting of stacked Belleville washers is housed on the sleeve member **8**. The latter and the nut protuberances **17** form the two end abutments for the spring **33** and with the spring are referred to herein as the spring assembly. As can be seen, this assembly is rotatably mounted within the starter casing and upon shaft **9** by the bearing balls **10** and **20**. A friction device in the form of a fiber strip **32** on each side of a ratchet wheel **32***a* transmits the starting effort from the handle **2** in the winding direction without encountering opposition from the pawls in the housing co-operating with the ratchet. The ratchet wheel **32***a* co-operating with the pawls prevents reverse rotation of the handle due to stored energy in the spring **33** transmitted by the shaft through the reversible screw mechanism **18, 19, 20**. Slow release of the stored energy can be obtained by turning the handle in the reverse, unwinding direction. This results in breaking of the friction lock between the fiber strips **32**, ratchet wheel **32***a*, handle **2** and spindle **3**, enabling spindle **3** then to rotate with respect to handle **2** due to the energy stored in the spring being released to some extent and then causing the friction lock to be again restored. Further turning of the handle in the reverse, unwinding, direction enables progressive release of the stored energy to be obtained. Starting effort applied through turning of the handle attachment **2** causes the shaft **9** to rotate (since spring **33** tends to hold nut **16** and its protuberances **17** in its right hand position) with initial displacement of the starter pinion **30** towards the right, and then, after engagement of the starter pinion **30** with the flywheel of an engine with concomitant locking of the main shaft **9**, the spring **33** is compressed for storage of the starting effort, with the nut **16** and its protuberances **17** being constrained to turn with the sleeve member **8**. Manual depression of the lever **31** then enables the stored starting effort to be exerted on the flywheel of the engine to be started. The degree of compression of spring **33** can be viewed through a sighting aperture **34**.

Operation

To wind the starter, the handle attachment **2** is turned by a convenient handle to cause the spindle **3** to rotate and thence through meshing bevel gears **4** and **5** and dogs **7** the sleeve member **8** to rotate about its axis. The rotational force of the sleeve **8** has two transmission outlets available thereto, with the first outlet being through shaft **9**, the multi-start helical groove **23** and bearing balls **24** to the sleeve member **25** and the second outlet being to the nut **16**. The first outlet has a certain degree of resistance while the second has a degree of resistance in which is included the resistance to compression of the spring **33**, with the latter resistance being far greater than the former resistance.

In consequence, the rotational force of the sleeve **8** is, as already described, first utilized in advancing sleeve member **25** with starter pinion **30** by screwing along helical grooves **23** until their end is reached, with the pawl **27** restraining sleeve member **25** against rotation.

Advancement of the starter pinion **30** to the right along the first part of the shaft **9** enables it then to mesh with the flywheel of an engine to be started; should the teeth of the starter pinion **30** not be in correct angular disposition for intermeshing with the flywheel teeth to take place an increased resistance will be imposed to the linear motion of the ratchet member **26** resulting in slight displacement of the pawl **27** with consequent slight rotation of the sleeve member **25** to allow the teeth of the starter pinion **30** and the flywheel then to intermesh.

With the starter pinion **30** interlocked with the flywheel, the shaft **9** is then prevented from rotating and the drive of the sleeve **8** is then exerted on to the second outlet therefor, namely the nut **16**. The rotation of the nut **16** now that shaft **9** is locked, causes the nut to move to the left along the keyways provided therefor in the sleeve member **8**, compressing the spring **33**.

When a start is to be effected, with spring **33** being compressed, the lever **31** is manually depressed to release pawl **27** from engagement with ratchet **26** to enable the main shaft **9** to rotate. The starting effort stored in the spring **33** is then dissipated through the starter pinion which is meshed with the flywheel of the engine.

Should it be desired to release the stored energy of the spring without a start of the engine being effected, the handle attachment **2** can be turned in the reverse, unwinding direction for progressive release of the stored energy.

One advantage of the construction illustrated in the accompanying drawing is the particular ease of assembly. The sleeve member **8** is slidably mounted on the main shaft **9** and there is a small clearance between the right hand end of the sleeve and the nosepiece **12**. Of course, the spring **33** keeps the sleeve member **8** pushed to the left, but for assembly purposes it suffices to push the sleeve against the thrust of this spring, when the bearing balls **10** can be slipped in position. If now the sleeve member **8** is released, the bearing balls hold it engaged on the shaft.

We claim:

1. A spring starter for an internal combustion engine comprising a main shaft having a first portion and a second portion, a starter pinion mounted on said first portion, a spring assembly arranged for storing the starting effort mounted on said second portion, a drive arrangement for imparting starting effort to the spring assembly positioned at or towards an end of the main shaft, the spring assembly being rotatably mounted on the second portion for rotation relative to the starter as a whole and said spring assembly comprising a shoulder sleeve serving as one abutment for the starter spring which is journalled on said second portion of the main shaft by a ball race which can be opened to permit insertion or withdrawal of the bearing balls by sliding the sleeve against the thrust of the starter spring, with the sleeve being withdrawable from the main shaft when the bearing balls are removed.

2. The starter according to claim **1** in which the starter pinion is resiliently constrained against rotation between a resting position and an engine engaging position so that if advance of the pinion to its engine engaging position is hindered, the resilient constraint can yield at least partially to permit some degree of rotation of the starter pinion.

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