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[54] WORM DRIVE FOR STARTER MOTORS FOR INTERNAL COMBUSTION ENGINES

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[58] **Field of Search** ..... 74/6, 7 A, 7

[56] **References Cited**

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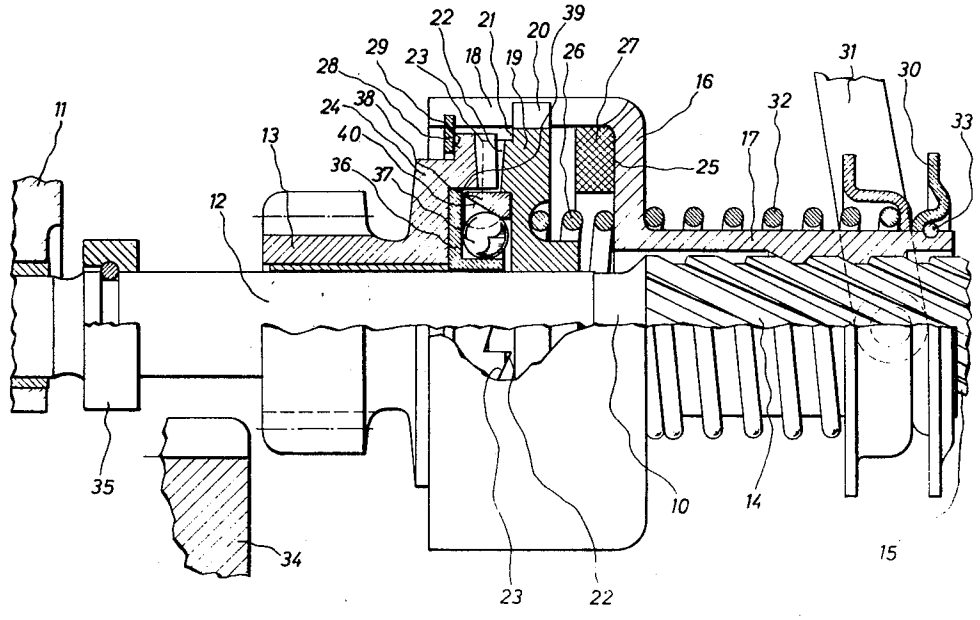
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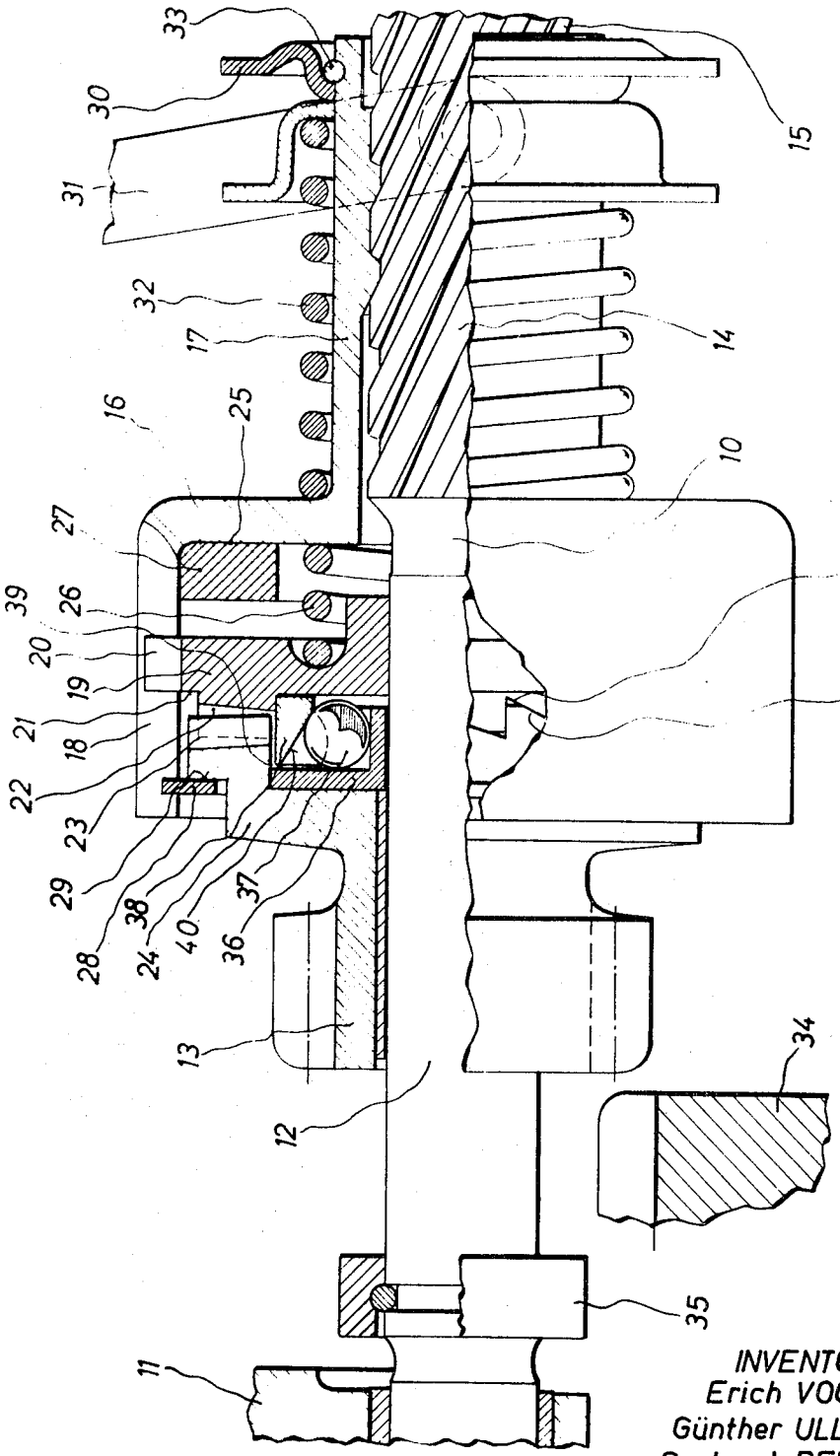
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[57] **ABSTRACT**

An overrunning clutch connects the start pinion to an axially movable coupling member coupled to the armature-shaft-rotated drive member by an ear that freely engages a longitudinal groove in the drive member, which has an internally threaded sleeve that meshes with the threaded portion of the armature shaft and is turned thereby.

9 Claims, 1 Drawing Figure





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WORM DRIVE FOR STARTER MOTORS FOR INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The invention relates to a worm drive for a starter motor for internal combustion engines.

Worm drives for this purpose frequently have a coupling that is rigid in one direction of rotation, the coupling occurring between the teeth of a coupling member turned by a driver and those of another part associated with the start pinion, which teeth together to form an overrunning clutch. Such drives, because of the rigid coupling, are particularly suited to the transmitting of large torques, as is necessary, for example, when starting high-speed diesel engines with direct fuel injection. The drive, however, is severely stresses by the shock occurring when the teeth of the turn pinion mesh with those of the spur gear of the internal combustion engine, by the peak torques that are transmitted during starting up, and by the forces exerted on the teeth of the overrunning clutch after the engine has started and has accelerated to an r.p.m. greater than that of the armature shaft of the starter motor.

In one known embodiment of this kind of worm drive, the means for ensuring a rigid coupling in rotation between the coupling member and the drive are provided on a surface of the coupling member that faces a sleeve of the driver. This construction has the disadvantage that the aforementioned means, because it is located only a relatively small radial distance from the axis of the armature shaft of the starter motor, is subject to very high forces and therefore quickly wears.

SUMMARY OF THE INVENTION

An object of the invention is a heavy duty worm drive that is wear resistant and has a long life, yet is composed of simple parts that are easily assembled together to make the worm drive.

The invention comprises broadly a driven gear on the engine, a driving gear, such as a turn pinion, arranged to be put into and out of mesh with the driven gear, a rotary input shaft, such as an armature shaft, of a starter motor, drive means movable axially of and operatively connected with the input shaft to perform an angular movement in response to axial movement, shifting means for moving the drive means axially, and coupling means comprising a first member radially spaced from the input shaft and provided on the drive means, and a second member coupled to the first member and operatively connected to the driving gear to move the latter angularly and axially into mesh with the driven gear in response to axial movement of the drive means.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a longitudinal view, partly cut away and partly in cross section, of an embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The armature, or input, shaft **10** of a starter motor, not shown, is supported at its left end in a bearing plate **11**, for rotation. The shaft has a smooth length **12**, which supports a turn pinion, or driving gear, **13**, free to rotate and to move axially. It also has a length **14** with a coarse thread **15**, onto which is screwed a cup-shaped driver **16** having an internally threaded sleeve **17**. The driver has at least one longitudinal slot **18** in its circumference, and advantageously has a plurality of such slots uniformly spaced about the circumference. If the slotted circumference of the driver is considered as being the first member of a coupling arrangement, the coupling member **19** constitutes the second member. This latter member, which is free to rotate and to move axially on the shaft **10**, has an ear **20**, constituting the male element, that freely engages a slot **18**, constituting the female element, so that the coupling member **19** can easily move axially on the shaft. The face **21** of the coupling member **19** facing the pinion **13** has saw-toothed coupling teeth **22** that mesh with similar teeth **23**, which are incorporated in the face of a flange part **24** of the pinion **13** that projects into the cup-shaped driver **16**. A coil spring **26**, held in compression between the member **19** and the inner face of the radial wall **25** of the driver **16**, presses the teeth **22** and **23** into engagement. These teeth constitute an overrunning clutch, which permits the shaft **13** to rotate relative to the driver **16**, when the engine that is to be started has started up and accelerates the pinion **13** with respect to the armature shaft **10** of the starter motor. An elastomeric ring **27** is fixed in any suitable manner to the inner face of the wall **25**. The parts **19** and **24** are held inside the cup-shaped driver **16** by a retaining ring **28**, which bears against the face **29** of the flange **24** and is held in an internal annular groove in the driver **16**.

The sleeve **17** supports a two-piece collar **30**, which the forked arm of a starting, or engaging, lever **31** engages. A coil spring **32**, which is supported at its left end by the outer face of the radial wall of the driver **16**, presses the collar **30** against a retaining ring **33** rigidly held on the sleeve **17**. The lever **31** is operated by a starting relay, not shown, and, by means of the spring **32**, the driver **16**, and the coupling member **19**, pushes the pinion **13** into mesh with the spur gear of the internal combustion engine, not shown. The position of the pinion **13** when completely engaged is determined by a stop ring **35** rigidly held on the shaft **10**.

The manner of constructing the coupling member **19** and the driver **16** so as to couple them together in rotation, while the member **19** remains completely free to move axially, ensures that the coupling between **16** and **19** occurs at a greater radial spacing from the shaft **10** than is the case in the embodiment of the prior art previously discussed.

When disengaging the teeth **22** and **23**, the action of the overrunning clutch is helped by a centrifugal force uncoupler, located between the coupling member **19** and the flange **24** and consisting of a ball race **36**, at least two uniformly spaced balls **37** in the race, and a conical ring **38**. The race **36** is securely held in an annular recess **39** of the flange **24**. The conical ring **38** is fixed to the face **21** of the member **19**, and its conical surface **40** rests on the balls **37**. These parts are so dimensioned that even when the overrunning clutch is completely engaged the balls **37** are held with virtually no axial play between the ball race **36** and the conical ring **38**.

In operation, the electromagnetically operated starting lever **31** pushes the collar **30**, the driver **16**, the coupling member **19**, and the turn pinion **13** towards the spur gear **34**. If the teeth of the pinion and the spur gear are positioned so as to permit their meshing, the engaging movement is continued until the pinion reaches the stop ring **35**. At this moment a starter switch, not shown, is closed in the usual manner, and the starter motor is turned on. The armature shaft is set into rotation, and the driver **16** is screwed along the coarse thread **15** towards the spur gear **34**. By means of the elastomeric ring **27** and the coupling member **19** it presses the pinion **13** against the ring stop **35**. The internal combustion engine is turned over by the pinion **13**, which, in turn, is rotated by the shaft **10** acting through the driver **16**, the coupling member **19**, and the teeth **22** and **23**, which are held in positive engagement in the direction of rotation.

The elastomeric ring **27** largely reduces the shock that occurs when the driver **16** strikes the coupling member **19**, and the pinion **13**, which is in mesh with the spur gear **34**, starts up. Moreover, during rotation the elastomeric ring appreciably moderates the torque peaks that are transmitted to the armature shaft **10**. The elasticity of the ring enables the worm drive of the invention to operate more smoothly, with less noise, and, above all, with less wear than worm drives of the prior art.

In accordance with the invention, the coil spring **26** can also be used in conjunction with the elastomeric ring **27** to obtain the cushioning effect. Although the ring is advantageously retained, it can be eliminated and the cushioning obtained solely from the spring **26**.

If the teeth clash when trying to mesh the pinion **13** and the spur gear **34**, the driver **16** is pushed, by means of the starting lever **31**, the collar **30**, and the spring **32**, still farther leftward until the elastomeric ring **27** presses against the coupling member **19**. The driver **16**, the coupling member **19**, and the pinion **13** are rotated by the coarse thread **15**, as a consequence of which the teeth of the pinion and the spur gear come into mesh in many cases before the starter motor is turned on.

If the pinion **13** is not sufficiently rotated, or if two teeth clash edge on edge, the starting lever **31**, once the elastomeric ring **27** presses against the coupling member **19**, moves the collar **30** leftward, compressing the spring **32**, until the starting relay, not shown, closes the starting switch. The starter motor runs and turns the tooth of the pinion **13** past the opposite tooth on the spur gear, so that the force of the compressed spring **32** can push the pinion **13**, by means of the coupling member **19** and the driver **16**, into mesh with the spur gear **34**. The shaft thread **15** screws forward the assembly of **16**, **19** and **13** until the pinion strikes the ring stop **35**.

When the internal combustion engine starts, the spur gear accelerates the pinion, which now turns faster than the armature shaft **10**. The pinion therefore exerts through the backs of the saw teeth **23**, and in a direction away from the pinion **13**, an axial force on the teeth **22** of the coupling member **19** and on the driver **16**. The pinion also exerts an accelerating circumferential force on the driver **16** with respect to the shaft **10**. The effect of these two forces and the action of the coarse thread **15** moves the driver to the right, until the retaining ring **28** strikes the face **29** of the pinion flange **24**. The acceleration of the pinion **13** reverses the load on the teeth **22** and **23**, whereby these teeth, as a consequence of their saw tooth shape, unmesh against the force of the spring, in the manner of an overrunning clutch, until the pinion **13** runs free.

The separation of the teeth **22** and **23** is helped and accelerated by the centrifugal force uncoupler between the pinion **13** and the coupling member **19**. As the rotational speed increases, the balls **37** are pressed outwards by the centrifugal force. The resulting force acting on the conical surface **40** of the ring **38** has an axial component that forces the coupling member **19** against the spring **26** so as to unmesh the teeth **22** and **23** quickly and reliably.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in a worm drive for starter motors for internal combustion engines, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and described to be protected by Letters Patent is set forth in the appended claims:

1. In a starter arrangement for internal combustion engines, a combination comprising a driven gear on the engine; a driving gear arranged to be put into and out of mesh with said driven gear; a rotary input shaft of a starter motor; drive means movable axially of and operatively connected with said input shaft to perform an angular movement in response to axial movement; shifting means for moving said drive means axially; and coupling means comprising a first member radially spaced from said input shaft and provided on said drive means, a second member movable axially of said drive means and coupled to said first member in operative connection with said driving gear to move the latter angularly and axially into mesh with said driven gear in response to axial movement of said drive means, and cushioning means between said second member and said drive means for reducing the severity of shocks transmitted to said drive means during startup and acceleration.

2. A combination as defined in claim **1**, including an overrunning clutch operatively connecting together said second member and said driving gear; and resilient means for biasing said overrunning clutch into engagement.

3. A combination as defined in claim **2**, wherein said driving gear comprises a part adjacent said second member, and said overrunning clutch includes mating teeth on said driving gear part and on said second member.

4. A combination as defined in claim **3**, wherein said second member is movable axially of said drive means, and including a centrifugal force uncoupler for helping to disengage said overrunning clutch against the force of said resilient means when said driving gear is accelerated by the engine started up.

5. A combination as defined in claim **4**, wherein said centrifugal force uncoupler includes an annular ball race in said driving gear part, at least two uniformly spaced balls in said race, and a ring associated with said second member and having a conical surface that is substantially contiguous with said balls and is sufficiently borne upon thereby when the engine accelerates during starting to establish a component of force that acts against said second member to oppose the force of said resilient means.

6. A combination as defined in claim **1**, wherein said second member includes a male element and said first member a female element freely accepting said male element so as to permit free axial movement of said second member with respect to said drive means.

7. A combination as defined in claim **1**, wherein said drive means comprises a wall extending radially of said input shaft and adjacent said second member, and said cushioning means is held on said wall.

8. A combination as defined in claim **7**, wherein said drive means includes a sleeve that surrounds a length of said input shaft and is operatively connected thereto.

9. A combination as defined in claim **8**, wherein said sleeve is internally threaded and said input shaft length has a thread that meshes with that of said sleeve.

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