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[54] STARTER DRIVE FOR COMBUSTION ENGINES

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

[56] **References Cited**

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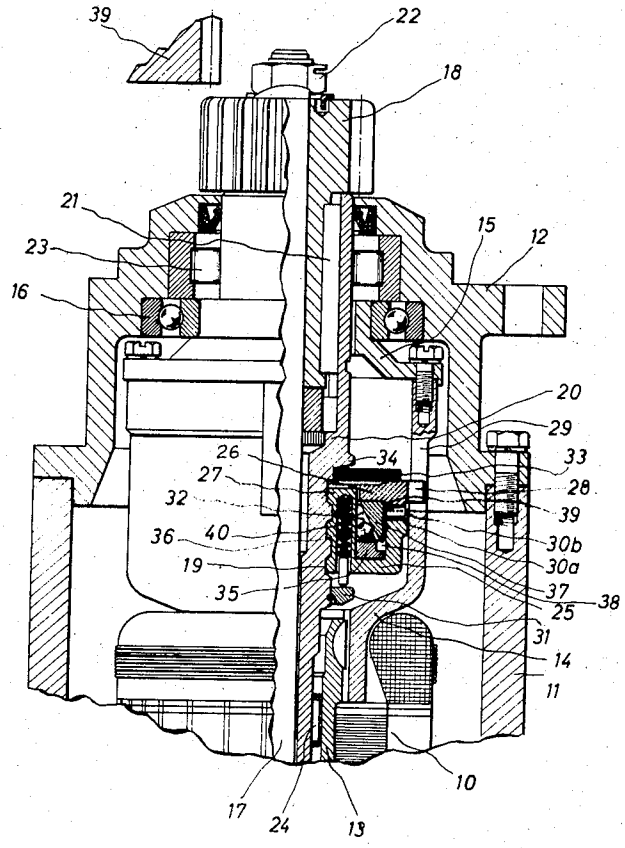
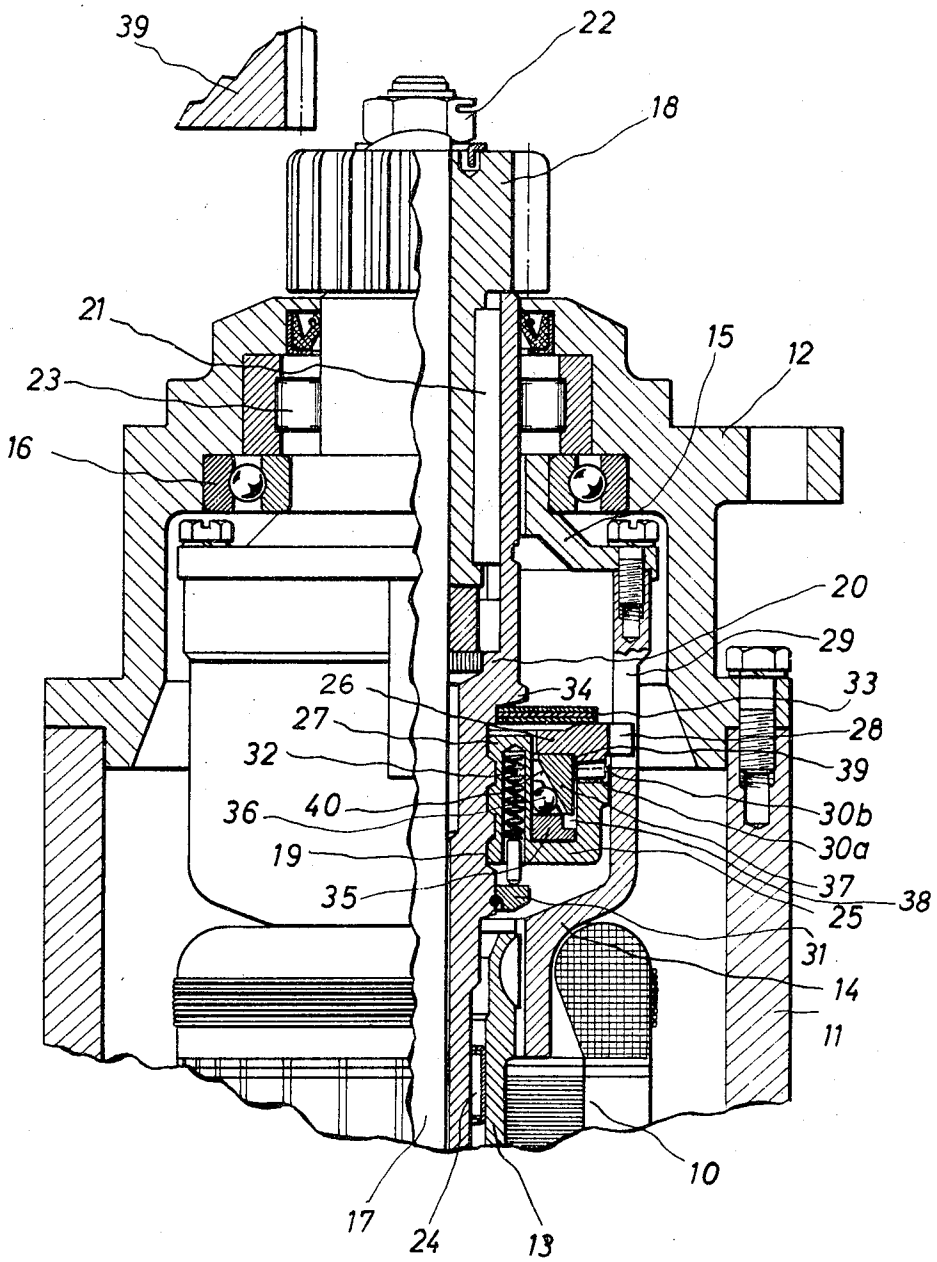
[57] **ABSTRACT**

An axially shiftable rotatable rod is mounted with radial clearance in the hollow output shaft of a motor. A pinion is fixed on the rod and at least in part located outwardly beyond the shaft so that it can mesh with a gear of a combustion engine to be started. A sleeve surrounds the rod fixed with the pinion and has an outer steep-pitch thread. A motion-transmitting coupling is provided including a first coupling element mounted in the shaft for rotation therewith and a second coupling element carried by the sleeve for rotation therewith. The coupling elements are provided with mechanically interlockable coupling projections and damping means is located between the sleeve and the first coupling portion and serves for damping axially directed forces.

10 Claims, 1 Drawing Figure





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STARTER DRIVE FOR COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The present invention relates generally to starter drives, and specifically to starter drives for combustion engines.

Various different types of starter drives for combustion engines are known, including a sliding type having a positively driven and a following coupling portion, which are constructed as friction disks which are slid or pushed into frictional abutment with one another for motion-transmitting purposes, when the starter drive is energized. The present invention is concerned with this type of starter drive, where two coupling portions or coupling elements are brought into motion-transmitting engagement.

It has been found in the aforementioned prior-art constructions that a significant amount of wear occurs on the friction disks even after a relatively short period of use; particularly where starter motors of relatively high capacity are involved, this can quite rapidly lead to damage to the friction disks of such magnitude that one or both of them will break.

SUMMARY OF THE INVENTION

It is, accordingly, an object of the present invention to overcome these disadvantages.

More particularly it is an object of the present invention to provide an improved starter drive of the type under discussion which is not possessed of these disadvantages.

A concomitant object of the invention is to provide such an improved starter drive which is capable of withstanding high stresses, such as for instance occur during starting of rapidly rotating direct-injection diesel engines, and which has a long life and is highly resistant to wear.

Still another object of the invention is to provide such an improved starter drive which is simple in its construction.

In pursuance of the above objects, and others which will become apparent hereafter, one feature of the invention resides in a starter drive for combustion engines which, briefly stated, comprises a motor having a hollow output shaft and an axially shiftable rotatable rod mounted with radial clearance in this shaft. A pinion is fixed on the rod and at least in part extends outwardly beyond the shaft so that it can mesh with a gear which in turn is intended to transmit motion to the combustion engine to be started. A sleeve surrounds the rod fixed with the pinion and has an external steep-pitch thread. Motion-transmitting coupling means is provided including a first coupling element mounted in the shaft for rotation therewith, and a second coupling element carried by the sleeve. Cooperating interlockable coupling portions are provided on the coupling elements and damping means is located between the sleeve and the first coupling portion and is operative for damping axially directed forces.

With the present invention we obtain a starter drive in which all components for motion transmission, both the components which connect the one coupling element with the shaft as well as the components which connect the two coupling elements with one another when motion is to be transmitted, are relatively far spaced from the axis of rotation of the output shaft of the motor, which is advantageous because this feature in conjunction with the provision of the damping means which substantially reduces the torque peaks acting upon the drive when the starting operation begins and the stresses acting upon the drive when the teeth of the pinion first move into mesh with the teeth of the engine-associated gear, the resistance to wear and thereby the life of the drive are substantially increased over what is known from the prior art.

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 partially broken-away, partially longitudinally sectioned fragmentary illustration of one embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing the drawing in detail it is pointed out that reference numeral **39** identifies a rotatable gear having an outer annulus of gear teeth, and being connected in suitable manner with a combustion engine which is to be started. The combustion engine and the axis of rotation of the gear **39** have not been illustrated, nor has the gear **39** itself been illustrated in more than fragmentary form. The reason for this is that the gear **39**, its arrangement and its connection with a combustion engine, are all entirely conventional and neither form a part of the present invention nor present any problems of understanding to those skilled in the art. The present invention is concerned solely with the novel starter drive which can be substituted in toto for any prior-art starter drive of the type driving a gear which in turn is connected in motion-transmitting relationship with a combustion engine. Therefore, the cooperation of the novel starter drive with such a gear and with such a combustion engine will be readily understood by those having ordinary skill in this field.

Coming to details of the FIGURE, it will be seen that reference numeral **10** identifies a fragmentarily illustrated, electrically operable starter motor **10** surrounded by a housing **11** whose open side is closed by a bearing flange **12**. The motor **10** in this embodiment is of the type which can be energized to turn over at a low number of rotations per minute, as well as being capable of energization for turning over at a high number of rotations per minute. Again, the manner in which this is done is well known to those skilled in the art and is therefore not believed to require a separate description.

The output shaft **13**, which is rotated when the motor **10** is energized, is hollow and has secured to it a cup-shaped entrainment member or driver **14** the open side of which is closed by a closure member **15** which in turn is turnably journalled in the flange **12** by means of a ball bearing **16**.

An axially shiftable rod **17** extends through the hollow output shaft **13**, the cover **15** and the flange **12**, and carries for rotation with it a pinion **18** and a sleeve **20** which is nonrotatably connected with the pinion **18** by the key **21** and provided on its outer circumferential surface with a steep-pitch thread **19** as illustrated. A nut **22** fixedly connects the pinion **18** and sleeve **20** with the rod **17**.

A roller bearing **23** journals the sleeve **20** in the flange **12**, and a needle bearing **24** journals the sleeve **20** in the hollow anchor shaft **13**; thus, the sleeve **20** is both rotatable and axially shiftable together with the pinion and the rod **17**.

An annular member **25** surrounds that portion of the sleeve **20** which is provided with the steep-pitched thread **19** and is provided with a correspondingly pitched internal thread meshing with the thread **19**. The member **25** constitutes the driven part of a coupling for motion-transmitting purposes between the motor **10** and the pinion **18**. The counterpart, that is the driving part of the coupling, is in form of an annular disk or plate **26** which is slidably accommodated on a hub **27** of the annular member **25** and provided on its circumference with at least one but in the illustrated embodiment several radial projections **28**. The driver **14** is provided with a plurality of circumferentially distributed longitudinal slots **29**, the number of such slots evidently corresponding to the number of projections **28**, and the projections **28** each are received with some play in the respective slots **29** and have freedom of movement axially of the slots **29** and therefore of the shaft **13**.

As the drawing shows, the facing end faces of the members **25** and **26** are each provided with an annulus of sawtooth-shaped coupling projections or teeth **30*a*** and **30*b***, respectively, and these are normally urged into meshing engagement by the biasing force of a helical spring **32** which bears upon the member **25** and an abutment ring **31** mounted on the sleeve **20**.

According to the present invention there is also provided damping means, here in form of a plurality of disk springs **33** which abut against a shoulder **34** provided on this purpose on the sleeve **20**. The coupling member **26** in turn abuts against the springs **33** with that one of its axial end faces which is remote from the one provided with the teeth **30***b*. The teeth **30***a* of the member **25** and the teeth **30***b* of the member **26** together constitute an overrunning clutch which permits a relative rotation of the pinion **18** and the output shaft **13** when the combustion engine has started and, turning over under its own power, rotates the pinion **18** with a number of revolutions higher than that of the shaft **13**.

The disengagement of the teeth **30***a*, **30***b* upon operation of the coupling as an overrunning clutch is assisted by a centrifugal separating device located between the members **25** and **26** and composed of a ball cage **35**, balls or spherical members **36** and a conical ring **37**. Of these, the ball cage **35** is fixedly accommodated in a recess **38** of ring-shaped outline in the member **25**; the balls **36** are accommodated in the cage **35** and the conical ring **37** is fastened in a recess **39** provided on that end face of the member **26** which is directed towards the member **25**. The inner conically diverging surface **40** of the ring **37** engages the balls **36** and the components are so configurated and dimensioned that even when the teeth **30***a*, **30***b* are fully in engagement with one another, the balls **36** are retained axially without play between the cage **35** and the ring **37**.

The operation of the novel starter drive according to the present invention will already be understood from what has been set forth above.

Energization results from the energization of a non-illustrated displacing relay which causes the rod **17** with the sleeve **20** and the pinion **18** to shift axially towards the gear **39** of the non-illustrated combustion engine to be started. At the same time the motor **10** is energized at reduced voltage so that the shaft **13** rotates slowly with its rotation being transmitted via the driver **14**, the member **26**, the teeth **30***b* and **30***a*, the member **25**, the thread **19**, the sleeve **20** and the key **21**, to the pinion **18**. The pinion **18** thus is in slow rotation as it is advanced against the gear **39** with which it is intended to cooperate. If, now, a tooth of the pinion **18** abuts in end-to-end relationship against a tooth of the gear **39**, so that the teeth cannot immediately move into mesh, then the pinion **18** turns slowly with reference to the gear **39** until its teeth can move into meshing engagement with those of the gear **39**, that is until such time until the teeth of the pinion **18**—which continues to be urged forwardly in direction towards the gear **39**—can move into the spaces between the teeth of the gear **39**. The axially acting forces which result on engagement between the pinion **13** and the gear **39**, and on initial rotation of the latter, are substantially damped by the presence of the damping means in form of the springs **33** located between the sleeve **20** and the member **26**.

On the other hand, if an end face of a tooth on the pinion contacts an end face of a tooth on the gear **39**, in which latter tooth a groove or kerf has been formed due to wear, then the pinion is not capable of turning with reference to the gear **39** and the starting process must be repeated.

Once the teeth of the pinion **18** mesh fully with the teeth of the gear **39**, a non-illustrated main current switch is closed, that is the motor **10** is now fully energized and the shaft rotates at higher speed whereby the pinion **18** turns over the combustion engine via the gear **39**, until such time as the combustion engine begins to turn over by itself. Once this takes place, it will be the gear **39** which accelerates the pinion **18**, so that the latter now turns faster than the shaft **13** of the motor **10**. As a result of this, the pinion exerts a circumferential force via the thread **19** and trailing flanks of the teeth **30**a, on the teeth **30**b of the member **26** whereby the load acting upon the teeth **30***a*, **30***b* is reversed and because of their sawtooth-shaped configuration and the action exerted by the steeply-pitched thread **19**, on the member **25**, the teeth **30***a*, **30***b* separate against the urging of the spring **32** so that the pinion **18** can turn freely with reference to the shaft **13**. This separation is facilitated and speeded by the centrifugal separating device described, because at increasing rotation the balls **36** are pressed outwardly by the centrifugal force resulting in axial displacement of the member **25** counter to the force of the spring **32**, so that the teeth **30***a* and **30***b* become separated more quickly and more reliably.

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

While the invention has been illustrated and described as embodied in a starter drive for 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 desired to be protected by Letters Patent is set forth in the appended claims:

1. A starter drive for combustion engines, comprising a motor having a hollow output shaft; an axially shiftable rotatable rod mounted with radial clearance in said shaft; a pinion fixed on said rod and at least in part extending outwardly beyond said shaft; a sleeve surrounding said rod fixed with said pinion and having a steep-pitch external thread; motion-transmitting coupling means, including a first coupling element mounted on said sleeve for rotation therewith and having an axially extending hub, and a second coupling element carried by said hub; cooperating interlockable coupling portions on said coupling elements; and damping means between said sleeve and second coupling element and operative for damping axially directed forces.

2. A starter drive as defined in claim **1**, said sleeve having a radial outer shoulder proximal to said pinion intermediate the same and said thread; and wherein said damping means comprises annular spring means surrounding said sleeve and abutting against said shoulder.

3. A starter drive as defined in claim **1**, said coupling portions of said first and second coupling elements being constructed and configurated for cooperation in the manner of an overrunning clutch.

4. A starter drive as defined in claim **1**; further comprising centrifugal means between said coupling elements and operative for effecting disengagement of said coupling portions under predetermined operating conditions.

5. A starter drive as defined in claim **4**, said centrifugal means comprising a recess of circular outline provided in an axial end face of said first coupling element which is directed towards said second coupling element, a cage received in said recess and accommodating at least two equi-angularly spaced spherical members, and a conically configurated ring fixed with said second coupling element extending into said recess and having an inner circumferential surface contacting said spherical elements and conically diverging towards said first coupling element.

6. A starter drive as defined in claim **1**, said second coupling element being an annulus and having an axially directed end face facing towards said first coupling element; and wherein said coupling portions are first coupling projections on said end face and second coupling projections on said first coupling element.

7. A starter drive as defined in claim **11**; said motion-transmitting coupling means further comprising an impeller member rotatable with said shaft and in engagement with said second coupling element.

8. A starter drive as defined in claim **7**, wherein said impeller member has at least one slot extending axially of said

shaft, and wherein said second coupling element is annular and provided on its periphery with at least one radially projecting engagement portion received and guided with slight play in said slot.

9. A starter drive as defined in claim 1, said coupling portions comprising first and second coupling projections; and further comprising biasing means normally biasing said first and second coupling projections to interlocking engagement.

10. A starter drive as defined in claim 9, said biasing means comprising a helical spring having opposite ends one of which bears upon said first coupling element, and an annular abutment on said sleeve at a side of said first coupling element which is axially remote from said second coupling element, the other end of said spring bearing upon said abutment means.

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