United States Patent

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[54] **STARTER MECHANISM**
9 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **123/185**
[51] **Int. Cl.** **F02n 1/00**
[50] **Field of Search** ..... 123/185 (A), 185 (B), 185 (B1), 185 (B2)

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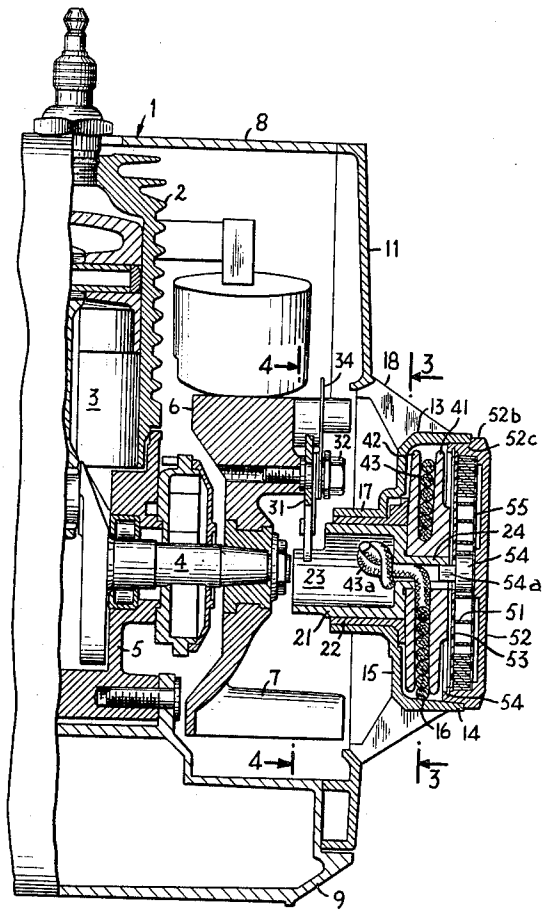
ABSTRACT: A rewind starter for an internal combustion engine having a combined flywheel and fan on one end of the crankshaft comprises a cup coaxial with the crankshaft rotatably supported in a bearing provided in a starter housing having a ring of openings to admit air to the flywheel. Pawls on the flywheel are releasably engageable with shoulders on the cup to couple the cup with the crankshaft. A starter pulley fixed on the outer end of the cup is received in a recess in the starter housing closed by a dished cover holding a rewind spring having its outer end secured to the cover and its inner end secured to an arbor rotatable with the cup and pulley.



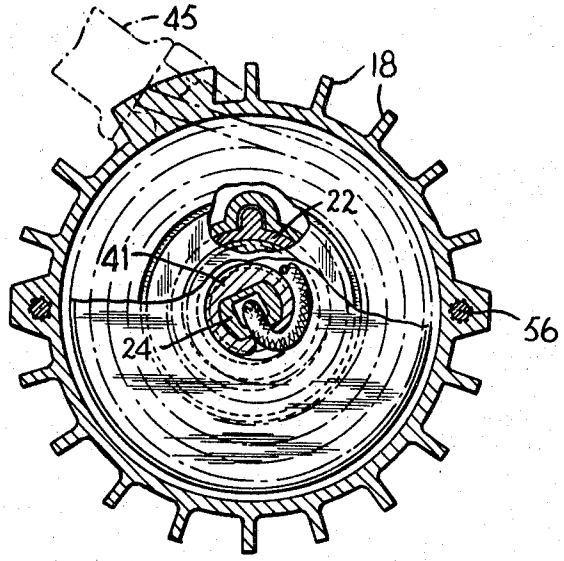


FIG. 3

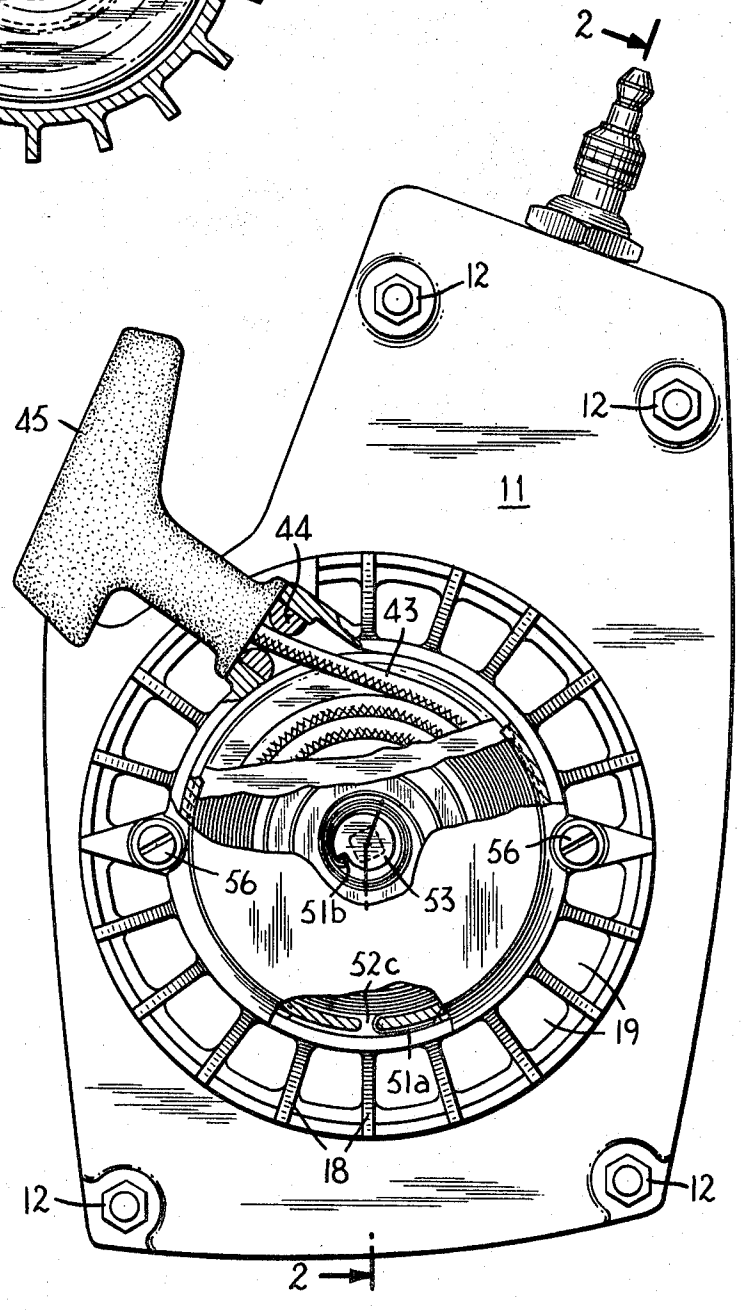
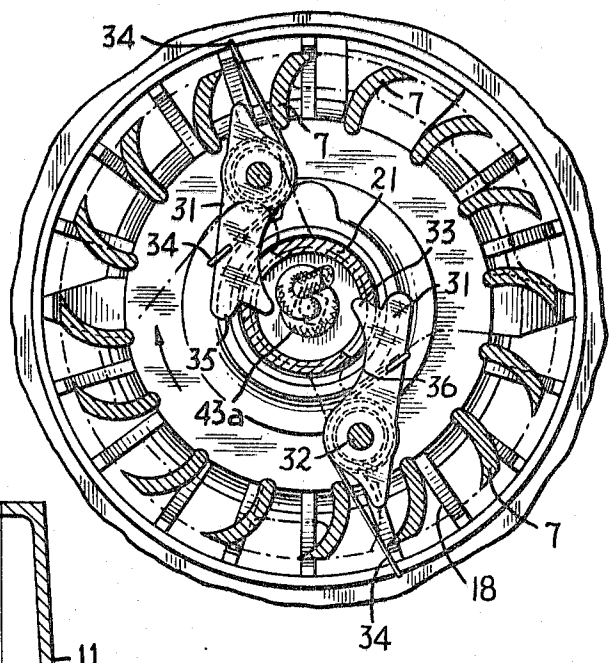


FIG. 1

FIG. 4



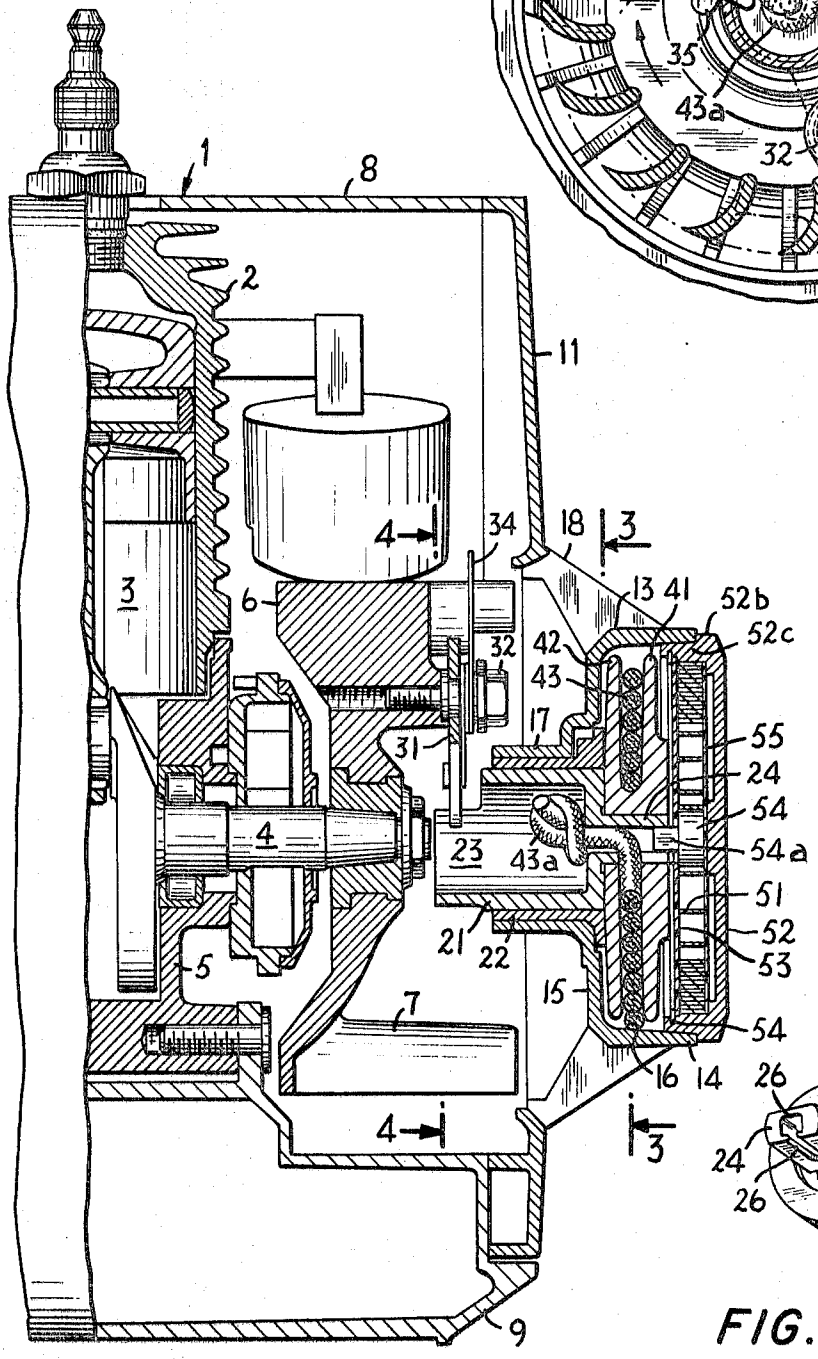


FIG. 2

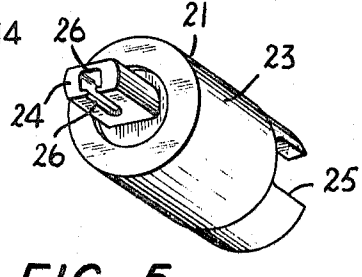


FIG. 5

STARTER MECHANISM

The present invention relates to a rewind starter assembly for an internal combustion engine. The starter assembly in accordance with the present invention is particularly suitable for small lightweight engines such as those used on chain saws and other portable power equipment.

It is an object of the present invention to provide rewind starter mechanism which is economical to manufacture and is compact and lightweight so that it does not add substantially to the size or weight of the engine on which it is installed.

A further object of the invention is to provide starter mechanism which is completely enclosed so as to protect it from water or dirt and at the same time is readily accessible for servicing without removal of the fan housing cover of the engine.

The objects and advantages of the invention will appear more fully from the following description in conjunction with the accompanying drawings in which:

FIG. 1 is a side view of an internal combustion engine having starting mechanism in accordance with the invention, portions having been broken away to show internal construction.

FIG. 2 is a partial cross section of the engine taken approximately on the line 2–2 in FIG. 1.

FIG. 3 is a cross section taken approximately on the line 3–3 of FIG. 2.

FIG. 4 is a cross section taken approximately on the line 4–4 in FIG. 2.

FIG. 5 is a schematic perspective view showing a starter cup which comprises a portion of the starter mechanism.

In the drawings there is shown in part an internal combustion engine 1 having a cylinder 2, a piston 3 and a crank shaft 4 rotatably supported in a crank case 5 by suitable bearings. On a projecting end of the crankshaft 4 there is secured a flywheel 6 provided with fan blades 7 for directing a flow of air over the engine to cool it. The engine is provided with a suitable case or housing 8 including a portion 9 providing a fuel tank. Although the engine illustrated by way of example in the drawings is a lightweight single-cylinder engine suitable for driving a chain saw or other portable equipment, it will be understood that the invention is in no way limited to the particular engine shown.

Rewind starter mechanism for the engine is housed in a fan and starter housing 11 which forms one side of the engine housing and is removably secured to the housing 8 and fuel tank portion 9, for example by stud bolts 12. The fan and starter housing 11 is formed to provide a cup-shaped portion 13 having a rim 14 and bottom 15 defining an outwardly opening recess 16. A bearing sleeve 17 coaxial with the crankshaft 4 extends inwardly from the recess 16 and terminates short of the hub portion of the flywheel 16. Around the cup-shaped portion 13, radially extending vanes 18 define a ring openings 19 which admit air to the fan comprising the fan blades 7.

A starter cup 21 is rotatably supported in axial alignment with the crankshaft 4 by an annular self-lubricating bushing 22 in the sleeve portion 17 of the fan and starter housing 11. The starter cup 21 has a cylindrical skirt portion 23 extending inwardly toward the flywheel 6 and an outwardly projecting reduced shank portion 24. The skirt portion 23 extends inwardly beyond the end of the sleeve 17 and is formed at its inner end with one or more recesses or cutouts 25, the side edges of which form axially extending shoulders. In the drawings, the skirt portion 23 is shown by way of example with two cutouts 25 which are diametrically opposite one another. As seen in FIG. 5 the shank portion 24 is flattened so as to provide opposite flat surfaces connected by arcuate surfaces. A square bore 26 extends axially through the shank portion 24 and opens to the interior of the sleeve portion 23. A slot 27 opens into the bore 26 from one of the flat faces of the shank portion 24.

At least one pawl 31 is pivotally mounted on the flywheel 6 by means of a shouldered stud bolt 32. In the drawings there are shown by way of example two such pawls mounted diametrically opposite one another on the flywheel. The pawls are

mounted in a position to engage the inwardly projecting end portion of the cylindrical skirt 23 of the starter cup 21. Each of the pawls has a nose portion 33 adapted to enter one of the recesses 25 provided in the starter cup 21 and to engage one of the longitudinally edges of the recess so as to provide a rotary driving connection between the starter cup and the flywheel. Each of the pawls is biased to turn about its pivot in a counterclockwise direction as viewed in FIG. 4 by a spring 34 so as to engage the cup. Inward movement toward the cup is limited by a shoulder 35 on the pawl. Moreover, the pawl is provided with a curved cam surface 36 engageable by the opposite edge of the opening 25 in the skirt portion 23 of the cup 21 so as to swing the pawls outwardly in the event the flywheel rotates in a clockwise direction as viewed in FIG. 4 faster than the cup 21. Moreover, the center of gravity of each pawl is located radially inwardly of the pivot post 32 so that when the flywheel rotates at a predetermined speed, for example engine idling speed or faster, the pawls are thrown outwardly out of engagement with the cup 21 by centrifugal force. An outwardly projecting portion 37 engages a suitable abutment on the flywheel, for example one of the fan blades 7, to limit the outward swinging of the pawls 31. It will be seen that with the pawls in the position shown in FIG. 4 rotation of the cup 21 in a clockwise direction is transmitted by the pawls 31 to the flywheel 6 and hence to the engine crankshaft 4. However, the cup 21 is free to turn in a counterclockwise direction and likewise the flywheel is free to overrun the cup 21 in a clockwise direction, for example when the engine starts.

A starter pulley 41 is received in the circular recess 16 of the fan and starter housing 11 and is press fitted onto the reduced shank portion 24 of the cup 21 so as to be fixed both rotationally and axially relative to the cup. An inner face of the pulley engages a flange portion at the outer end of the bushing 22 so as to provide a thrust bearing for the assembly comprising the pulley 41 and cup 21. The pulley 41 comprises axially spaced flanges defining between them a deep annular groove 42 to receive a starter rope 43 wound on the pulley. The term "rope" is used in a generic sense to include a flexible tension member such as a rope, cord or cable. The axial dimension of the groove 42 of the pulley is slightly greater than the cross-sectional dimension of the rope 43 so that when the rope is wound on the pulley it lies in a spiral convolution as illustrated in FIGS. 1 and 2. An inner end portion of the rope 43 extends radially inwardly through an opening in the hub portion of the pulley and through the opening 26 and bore 24 of the cup 21 into the interior of the skirt portion 23 and is secured by a knot or other enlargement 43*a* located inside the skirt portion 23. The inner end of the rope is thereby secured in a convenient and space-saving manner by utilizing space already available. An outer end portion of the rope 43 extends out through a grommet 44 in an approximately tangential opening in the rim portion 14 of the housing and is secured to a hand grip 45 by which the rope 43 can be pulled. By reference to FIG. 1 it will be seen that when the rope 43 is pulled by the hand grip 45, the pulley is rotated in a counterclockwise direction (as viewed in FIG. 1), the rope being thereby unwound from the pulley.

Spring means is provided for rotating the pulley in the opposite direction to rewind the rope 43 on the pulley. As illustrated in the drawings, the rewinding means comprises a spiral spring 51 housed in a dish-shaped circular cover 52 for closing the recess 16 of the fan and starter housing 11. A rim portion 52*a* of the cover fits into the recess 16 while a shoulder 52*b* limits inward movement. The outer end 51*a* of the spring 51 is secured to the rim 52*a* of the cover, for example by extending through an opening 52*c* in the rim and being bent back on itself as illustrated in FIG. 1. The inner end of the spring is secured to a mandrel 53, for example by having a bent over or enlarged portion 51*b* at the end of the spring engaged in a hook portion of the mandrel as illustrated in FIG. 1. The mandrel 53 has an axially inwardly projecting square stud portion 54 which extends into the square bore 24 of the starter cup 21 so as to couple the mandrel rotatively with the cup and with

the pulley 41. The spring 51 is retained in the cover 52 by a thin discyshaped shield 53 held by a retaining ring 54. A similar shield 53 (but without a central hole) is preferably interposed between the spring 51 and the cover 52 to confine and guide the spring. The cover 52 is suitably secured to the housing 11, for example by two screws 56.

By reference to FIG. 2 it will be seen that the starter mechanism comprising the starter cup 21, pulley 41 and spring 51 are accessible merely by removing the cover 52 and without the need of removing the fan and starter housing 11 from the engine. This construction facilitates assembly, disassembly, inspection, servicing and repair of the starter mechanism. When the parts have been assembled as seen in FIG. 2 but before the screws 56 have been inserted, initial tensioning can be applied to the spring 51 by rotating the cover 52 in a clockwise direction as seen in FIG. 1. When the desired amount of pretension has been applied to the spring, the screws 56 are tightened to secure the cover in place.

The operation of the starting mechanism will be readily apparent from the drawings and from the foregoing description. When the engine is stopped, the pawls 31 are pressed radially inwardly by the springs 34 so as to engage in the recesses 25 of the inwardly projecting skirt portion 23 of the starter cup 21. A pull on the starter rope 43 rotates the pulley 41 in a counterclockwise direction as seen in FIG. 1 and hence in a clockwise direction as seen in FIG. 4. This rotary movement is transmitted through the pawls 31 to the flywheel 6 and hence to the crankshaft 4 to crank the engine. Rotation of the pulley likewise is imparted to the arbor 53 so as to wind up and thereby tension the rewind spring 51. If the engine does not start on the first pull of the rope, tension on the rope is relieved to permit the rope to be rewound on the pulley by rotation of the pulley in a clockwise direction as seen in FIG. 1 by the rewind starter 51. The pawls 31 ride freely on the sleeve portion of the cup 21 and do not prevent rotation of the pulley to rewind the rope. When the engine starts so that the flywheel 6 overruns the sleeve 21, the pawls 31 likewise ride freely on the sleeve portion of the cup 21 until a speed is reached at which the pawls 31 are moved radially outwardly out of engagement with the cup 21 by centrifugal force. This preferably occurs at a speed lower than idling speed so that at all running speeds of the engine, including idling speed, the pawls are out of engagement with the cup 21.

while a preferred embodiment of the invention has been illustrated in the drawings and is herein particular described, it will be understood that the invention is in no way limited to the illustrated embodiment.

I claim:

1. In a rewind starter assembly for an internal combustion engine having a shaft and a wheel on said shaft, the combination of a starter housing having an outwardly facing recess with a bottom and an outwardly extending rim and an annular bearing extending inwardly from and supported by the bottom of said recess in axial alignment with the engine shaft, a starter cup rotatably supported in said bearing and having an integral skirt portion extending inwardly of said bearing toward said shaft and wheel and a shank portion extending into said recess, the inwardly extending skirt portion of said cup having at least one shoulder means, at least one pawl pivotally mounted on said wheel and engageable with said shoulder means of the skirt portion of said cup to cause said cup, wheel and shaft to rotate together, said pawl being spring biased to a position to engage said shoulder means and being movable by centrifugal force to a nonengaging position when said wheel rotates at or above engine idling speed, a starter pulley in said recess and fixed on the shank portion of said cup to rotate with said cup, a wound rope on said pulley for rotating said pulley and cup in one direction, and spring means for rotating said cup and pulley in the opposite direction to rewind said rope on said pulley.

2. A rewind starter assembly for an internal combustion engine having a shaft and a wheel on said shaft, the combination of a starter housing having an outwardly facing recess and an annular bearing extending inwardly from said recess in axial alignment with the engine shaft, a starter cup rotatably supported in said bearing and having a skirt portion extending toward said shaft and wheel and a shank portion extending into said recess, the skirt portion of said cup having at least one shoulder means, at least one pawl on said wheel engageable with said shoulder means of the skirt portion of said cup to cause said cup, wheel and shaft to rotate together, a starter pulley in said recess and fixed on the shank portion of said cup to rotate with said cup, a wound rope on said pulley for rotating said pulley and cup in one direction, and spring means for rotating said cup and pulley in the opposite direction to rewind said rope on said pulley, said spring means comprising a dished cover for said recess of the starter housing, a spiral spring received in said cover and having an outer end secured to the cover, and an arbor coaxial with and rotatable with said cup, the inner end of said spring being secured to said arbor.

3. A rewind starter assembly according to claim 2, in which said spring is retained in said cover by a shield interposed between said spring and said pulley and secured at its periphery to said cover.

4. A rewind starter assembly according to claim 1, in which said shoulder means comprises a recess in said skirt portion of said cup having an edge engageable by said pivoted pawl.

5. A rewind starter assembly for an internal combustion engine having a shaft and a wheel on said shaft, the combination of a starter housing having an outwardly facing recess and an annular bearing extending inwardly from said recess in axial alignment with the engine shaft, a starter cup rotatably supported in said bearing and having a skirt portion extending toward said shaft and wheel and a shank portion extending into said recess, the skirt portion of said cup having at least one shoulder means, at least one pawl on said wheel engageable with said shoulder means of the skirt portion of said cup to cause said cup, wheel and shaft to rotate together, a starter pulley in said recess and fixed on the shank portion of said cup to rotate with said cup, a wound rope on said pulley for rotating said pulley and cup in one direction, and spring means for rotating said cup and pulley in the opposite direction to rewind said rope on said pulley, said shank portion of said cup is hollow and in which said rope extends through an opening in a hub portion of said pulley and through said hollow shank portion into the interior of said skirt portion where it is secured by an enlargement in said rope.

6. A rewind starter assembly according to claim 2, in which a noncircular stud portion of said arbor extends into a noncircular recess in said cup to couple said arbor rotatively with said cup.

7. A rewind starter assembly according to claim 1, in which said wheel includes fan means for cooling the engine and in which said starter housing is provided with a ring of openings surrounding said recess to admit air to said fan means.

8. In a rewind starter assembly for an internal combustion engine having a crankshaft and a combined flywheel and fan mounted on one end of the crankshaft, the combination of a starter housing having an outwardly facing cup-shaped recess having a rim, a ring of openings surrounding said rim to admit air to said fan and an annular bearing extending inwardly from said recess in axial alignment with said crankshaft, a starter cup rotatable supported in said bearing and having a skirt portion extending toward said wheel and a reduced shank portion extending into said recess, means for releasably coupling said cup with said wheel, a starter pulley in said recess and fixed on the shank portion of said cup to rotate with said cup, a rope wound on said pulley for rotating said pulley and cup in one direction, and spring means for rotating said cup and pulley in the opposite direction to rewind said rope, said spring means comprising a dished cover for said recess, a spiral spring received in said cover and having an outer end secured to said cover, and a rotatable arbor coaxial with and rotatable with said cup, the inner end of the spring being secured to said arbor.

9. A rewind starter assembly according to claim 8, in which said cover has a rim portion rotatably received in said recess, said cover being rotated to apply initial tension to the spring, and in which means is provided for securing said cover in the position to which it has been rotated.