

[54] RECOIL ENGINE STARTER

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[58] Field of Search. 123/185 A, 185 B, 185 BA,
123/179 SE

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[57]

ABSTRACT

A recoil engine starter comprising a sheave to operate a crankshaft of an internal combustion engine by drawing a starting rope wound upon the sheave, a spring biasing the sheave in a rope recoiling direction, and a ratchet-and-pawl mechanism selectively transmitting the rotation torque of the sheave to the crankshaft. The sheave comprises a rope winding portion formed in a regular polygonal shape and the ratchet-and-pawl mechanism includes an engaging device to engage the sheave with the crankshaft at a plurality of engaging positions corresponding to the number of apexes of the polygonal shape.

5 Claims, 7 Drawing Figures

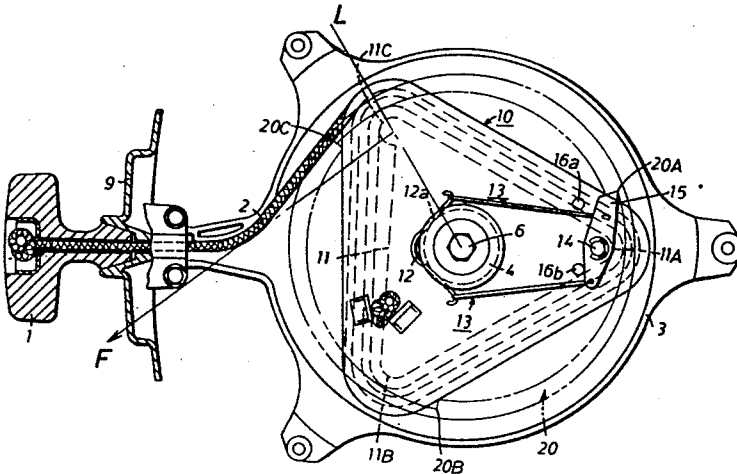
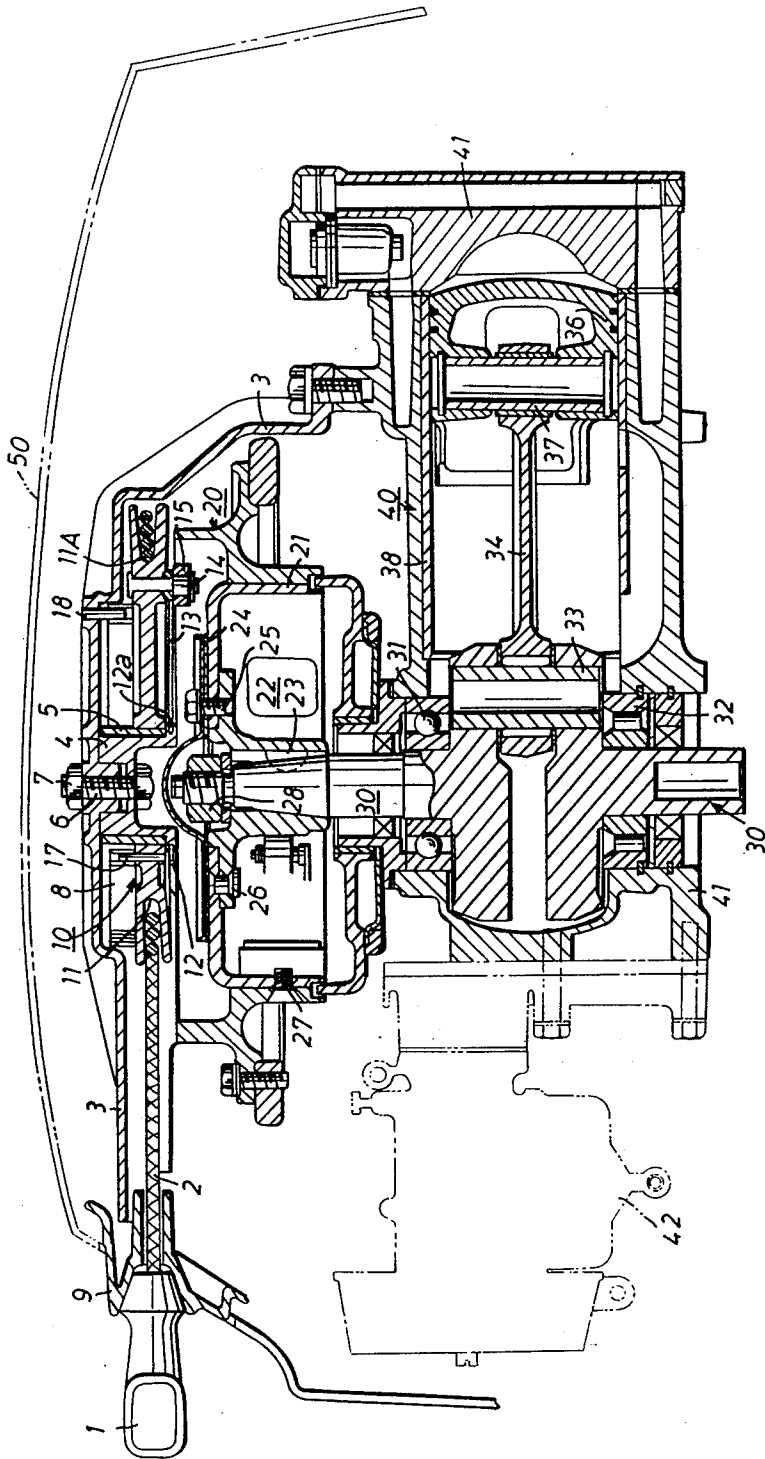


Fig. 1



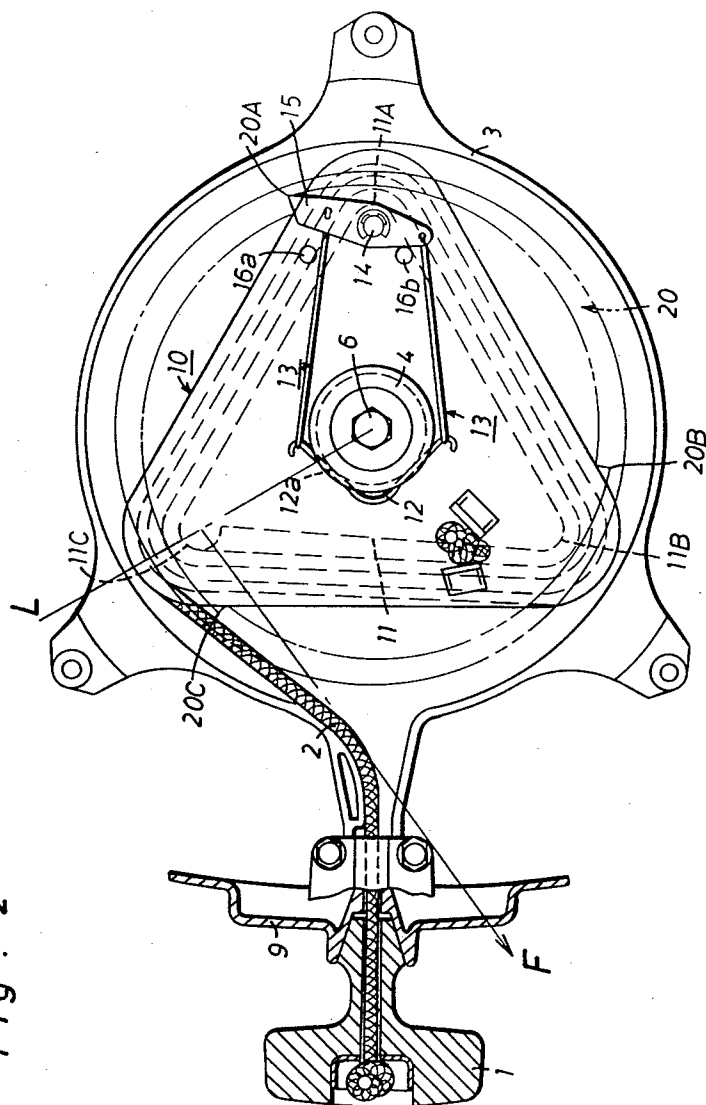


Fig. 2

Fig. 3

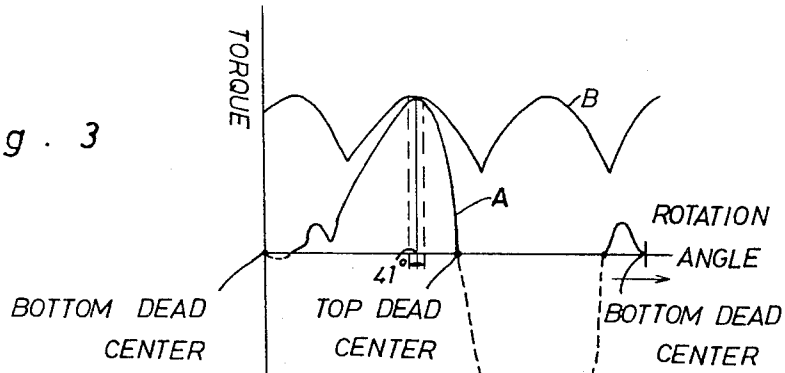


Fig. 4

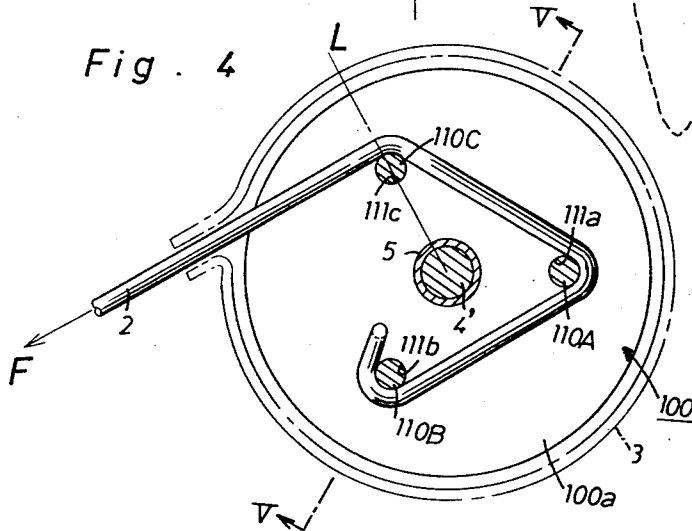
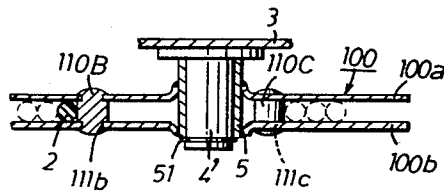


Fig. 5



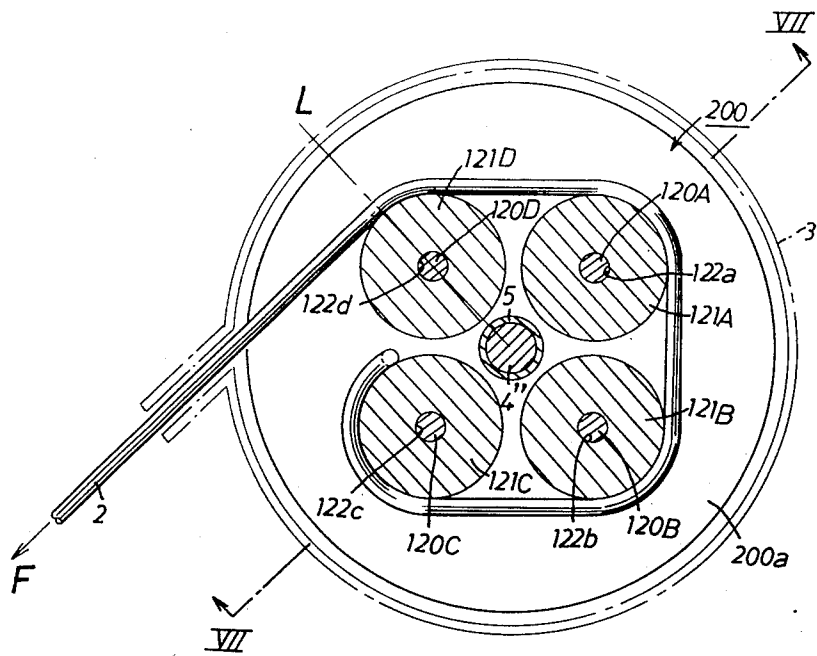
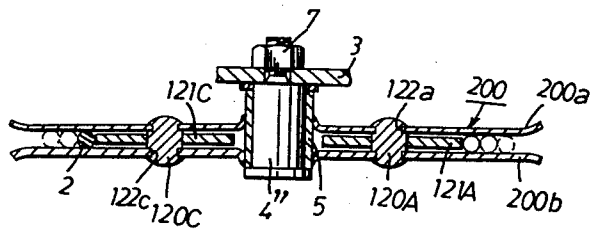


Fig. 6

Fig. 7



RECOIL ENGINE STARTER

BACKGROUND OF THE INVENTION

The present invention relates to a recoil starter of an internal combustion engine for an outboard motor, a snowmobile and the like, and more particularly to an improvement of a recoil starter of the type in which engine cranking operation is achieved by drawing a starting rope from a sheave and winding a spring which upon release of the rope, recoils the rope on the sheave.

In such a recoil starter of the type, the motion of the sheave in an engine cranking direction is generally transmitted to a crankshaft of the engine by a ratchet-and-pawl mechanism, and the largest rotation torque of the sheave is necessary only when the piston requires the largest torque in its compression stroke or the rotation angle of the crankshaft is position just before the arrival of the piston to its top dead center in the compression stroke. In the other strokes of the piston in one cranking cycle, the sheave torque for cranking is not so large as required in the compression stroke.

The conventional recoil starters of this type are provided with sheaves including circular rope winding portions. To start the engine, therefore, rather large rope pulling force is always required unnecessarily. And to effect the engine cranking operation with a smaller rope pulling force, the diameter of the circular rope winding portion has only to be made larger, which, in turn, raises another demerit that a longer rope has to be provided. When the winding portion is made smaller in diameter, the rope can be correspondingly made shorter, but a larger rope pulling force becomes necessary. In the conventional recoil starters, it is well observed that unnecessary cranking labour is wasted in the engine starting operation.

SUMMARY OF THE INVENTION

The prime object of the present invention is to provide a recoil engine starter to enable smooth engine starting operation without unnecessary labor.

Another object of the present invention is to provide a recoil engine starter, having the above-mentioned characteristics, wherein the overall size is very compact and a shorter stroke of rope pulling is enough to effect smooth engine starting operation.

A further object of the present invention is to provide a recoil engine starter, having the above mentioned characteristics, wherein the sheave can be formed substantially in any desired shape yet the same or better effect is obtained in engine starting operation.

Still another object of the present invention is to provide a recoil engine starter wherein the largest rotation torque of the sheave is exerted at the moment when the rotation angle of the crankshaft is positioned just before the arrival of the piston to its top dead center in the compression stroke.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects and advantages of the present invention will be more readily apparent from the following detailed description of embodiments thereof when taken together with the accompanying drawings in which:

FIG. 1 is a view partially in side elevation and partially in section showing an outboard motor head

equipped with a recoil starter embodying the present invention.

FIG. 2 is a bottom side view of the recoil starter shown in FIG. 1.

FIG. 3 depicts characteristic curves showing the necessary torque for the engine starting operation and the torque obtainable by the present invention, pulling the rope with constant force, wherein Y-axis represents the torque and X-axis shows the rotation angle of the crankshaft.

FIG. 4 is a diagrammatic bottom side view of the sheave in a second preferred embodiment of the present invention.

FIG. 5 is a sectional side view taken along line V—V in FIG. 4.

FIG. 6 is a diagrammatic bottom side view of the sheave in a third preferred embodiment of the present invention.

FIG. 7 is a sectional side view taken along line VII—VII in FIG. 6.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, particularly in FIG. 1, there is illustrated a preferred embodiment of a recoil engine starter in accordance with the present invention. The recoil starter mechanism is assembled within a starter housing 3 mounted on a crankcase 41 of an internal combustion engine 40 in which the cylinder 38 is horizontal. The crankcase 41 to which mixture is admitted from a carburetor 42 provides suitable bearing for a crankshaft 30 having usual crank to which a piston 36 is connected through a connecting rod 34 for reciprocation in the cylinder 38.

A starting handle 1 is attached at the end of a starting rope 2 which extends through a guide 9 in the starter housing 3. The rope 2 is wound upon a sheave 10 rotatably mounted on a bushing 4 through a sleeve 5 firmly pressed into the central portion of the sheave 10. The bushing 4 is secured under the starter housing 3 by way of a bolt 6 and a nut 7 and the sleeve 5 is rotatably mounted on the bushing 4.

As well illustrated in FIG. 2, the sheave 10 is formed in a regular triangular shape and positioned so that the pivot axis 4 is aligned to be coaxial with the crankshaft 30. A regular triangular winding groove 11 to wind up the rope 2 therein is drilled on the periphery of the sheave 10. A coil spring 8 is anchored between connecting portions 17 and 18 respectively provided on the sheave 10 and under the starter housing 3 (see FIG. 1). The sheave 10 is normally biased toward its recoiled position by way of the spring 8.

The winding groove 11 has three large diameter portions 11A, 11B and 11C, whereat the largest pulling force by the rope 2 is produced as detailed hereinafter. When the handle 1 is pulled to unwind the rope from the sheave 10, rotation of the sheave is accordingly made to effect engine starting operation. This rotation of the sheave 10 in an engine cranking direction is transmitted to the crankshaft 30 of the engine 40 by way of a ratchet-and-pawl mechanism.

As well illustrated in FIG. 2, the ratchet-and-pawl mechanism comprises a pawl 15 pivoted under the sheave 10 and three ratchet portions 20A, 20B and 20C provided on the inner wall of a drum 20. The drum 20 is secured by screws 27 on a rotor 21 of a flywheel magneto 22 mounted on the crankshaft 30 by way of

a woodruff key 23 and a locking nut 28 threaded on the top end of the crankshaft 30.

The pawl 15 is swingably journaled within the drum 20 by a pivot pin 14 under the sheave 10 and its swinging operation toward and outward the ratchet portions 20A, 20B and 20C is conducted by linking action of a pair of torsion wires 13, 13 anchored between the pawl 15 and a wire spring 12. The wire spring 12 is frictionally engaged within a circular holding groove 12a provided on the periphery of the lower end of the bushing 4. A pair of stopper pins 16a, 16b projects downwardly from the sheave 10 to regulate the swinging movement of the pawl 15.

When the rope 2 is pulled out, the pawl 15 engages with one of the three ratchet portions 20A, 20B and 20C of the drum 20 so as to transmit the rotation of the sheave 10 to the crankshaft 30 to crank the engine 40. The retracting operation of the pawl 15 from one of the ratchet portions 20A, 20B and 20C precludes transmission of rotation from the crankshaft 30 to the sheave 10.

The above embodied recoil starter is characterized in such a feature as described hereinafter. The sheave 10 is designed and positioned in respect of the position of the rotation angle of the crankshaft 30, so that an imaginary line L between the axial center of the sheave 10 and the top ends of the wound rope 2 at the large diameter portions of the groove 11 may cross substantially at a right angle against the direction of the rope pulling force just before the arrival of the piston at its top dead center in the compression stroke. Thus, the largest rotation torque for starting the engine is always produced in adequate timing by pulling out the rope 2.

This unique and effective feature is best explained by a graph of FIG. 3. In response to the rope pulling operation, the pivot pin 14 of the pawl 15 is displaced toward the pulling direction of the rope 2 to cause the linking action of the pair of torsion wires 13, 13 and the pawl 15 swings toward the inner side wall of the drum 20. The pawl 15 engages with one of the ratchet portions 20A, 20B and 20C positioned adjacent the pawl 15 in the rotating movement of the sheave 10 to transmit the rotation torque of the sheave to the crankshaft 30. As best observed from a characteristic curve B of the graph of FIG. 3, in which the tops of the curve B correspond with the largest rotation torque produced when each of the imaginary lines crosses at the right angle with the rope pulling force direction. One of the tops of the curve B corresponds without fail to the point just before the arrival of the piston to its top dead center in its compression stroke, the point being measured to be about forty one degree against the top dead center in the rotation angle of the crankshaft 30. Thus, the best effects in starting the engine is obtained by this device.

When the rope 2 is released, the sheave 10 is recoiled by the spring 8 to rewind the rope 2 upon the groove 11. In response to this recoiling operation, the pivot pin 14 is displaced toward the recoiling direction of the sheave 10 to cause the counter linking action of the torsion wires 13, 13 and the pawl 15 retracts from the ratchet portion.

Disclosed in FIGS. 4 and 5 is a second preferred embodiment of the present invention. This second preferred embodiment is characterized in a different construction of the sheave including the rope winding portions. All other constructions and operations are just

same as those in the first preferred embodiment and, therefore, no repetition is made. Same and similar reference numerals are used for the portions which have same function as in the first preferred embodiment.

A circular sheave 100 comprises a pair of disc plates 100a, 100b which are assembled to be in parallel with each other. The sheave 100 is welded at its center onto an annular sleeve 5 pivoted on a bushing 4' projecting downwardly integrally from the starter housing 3. An annular clip 51 locks the sleeve 5 rotatably at the lower end of the bushing 4'.

The sheave 100 is provided with three through holes 111a - 111c to receive respectively three winding pins 110A - 110C fixed by calking on the sheave 100. The holes 111a - 111c are so positioned as each of them comes to each apex of a triangle of which three apexes correspond with the large diameter portions 11A, 11B, 11C of the groove 11 in the first preferred embodiment.

Thus, the rope 2 is wound along the three pins 110A - 110C to effect the desired engine starting operation.

In FIGS. 6 and 7, disclosed is a third preferred embodiment of the present invention. This embodiment is characterized in the below constructional differences from the second preferred embodiment over the sheave including the rope winding portions.

In this preferred embodiment, the sleeve 5 is rotatably mounted over the bushing 4' with a large diameter portion to receive the lower end of the sleeve 5. The bushing 4' is firmly secured under the starter housing 3 by a nut 7 threaded on the screw portion thereof projecting up through the starter housing 3.

A sheave 200 constructed and assembled as that in the second embodiment is provided with four through holes 122a - 122d to receive respectively four winding pins 120A - 120D fixed by calking on the sheave 200.

The four holes 122a - 122d are positioned to correspond respectively with four apexes of a regular square. An imaginary line between the center of the sheave 200 and any one of the apexes of the square crosses substantially at the right angle to the rope pulling direction. So that the desired engine starting operation can be realized when the rope 2 wound along the four pins 120A - 120D is pulled.

For a better efficiency in the engine starting operation, rollers 121A - 121D may be journaled over the winding pins 120A - 120D respectively disclosed in this third preferred embodiment.

It should be clear that several modifications and variations are conceivable for the shape of the rope winding portions.

Having now fully set forth both structure and operation of preferred embodiments of the concept underlying the present invention, various other embodiments as well as certain variations and modifications of the embodiments herein shown and described will obviously occur to those skilled in the art upon becoming familiar with said underlying concept. It is to be understood, therefore, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically set forth herein.

What is claimed is:

1. In a recoil engine starter comprising a sheave to operate a crankshaft of an internal combustion engine by drawing a starting rope wound upon said sheave, a

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spring biasing said sheave in a rope recoiling direction, and a ratchet-and-pawl mechanism selectively transmitting the rotation torque of said sheave to said crankshaft, the improvement wherein said sheave comprises a rope winding portion formed in a regular polygonal shape and said ratchet-and-pawl mechanism includes means for engaging said sheave with said crankshaft at a plurality of engaging positions corresponding to a number of apexes of said polygonal shape, one of imaginary lines connecting the axial center of said sheave and one of the apexes of said polygonal shape crossing substantially at a right angle against the rope pulling direction just before the arrival of the piston of said engine at its top dead center in the compression stroke, wherein said sheave comprises a pair of disc plates rotatably assembled within a starter housing and a plurality of winding pins for connecting said disc plates to be in parallel to each other, said winding pins being arranged to form said regular polygonal rope winding portion.

2. A recoil engine starter as set forth in claim 1, wherein said rope winding pins are three winding pins arranged to correspond respectively with three apexes of a regular triangle, an imaginary line between the axial center of said sheave and any one of said three

6

winding pins crossing substantially at a right angle to the rope pulling direction just before the arrival of the piston of said engine at its top dead center in the compression stroke.

3. A recoil engine starter as set forth in claim 1, wherein said rope winding pins are four winding pins arranged to correspond respectively with four apexes of a regular square, an imaginary line between the axial center of said sheave and any one of said four winding pins crossing substantially at a right angle to the rope pulling direction just before the arrival of the piston of said engine at its top dead center in the compression stroke.

4. A recoil engine starter as set forth in claim 1, wherein said sheave further comprises a plurality of rollers respectively journaled on said winding pins between said disc plates, said starting rope being wound upon the periphery of said rollers.

5. A recoil engine starter as set forth in claim 3, wherein said sheave further comprises four rollers respectively journaled on said four winding pins between said disc plates, said starting rope being wound upon the periphery of said rollers.

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