June 20, 1950 W. A. FORBESS 2,511,908

ENGINE STARTER UNIT

Filed Oct. 29, 1947 2 Sheets-Sheet 1

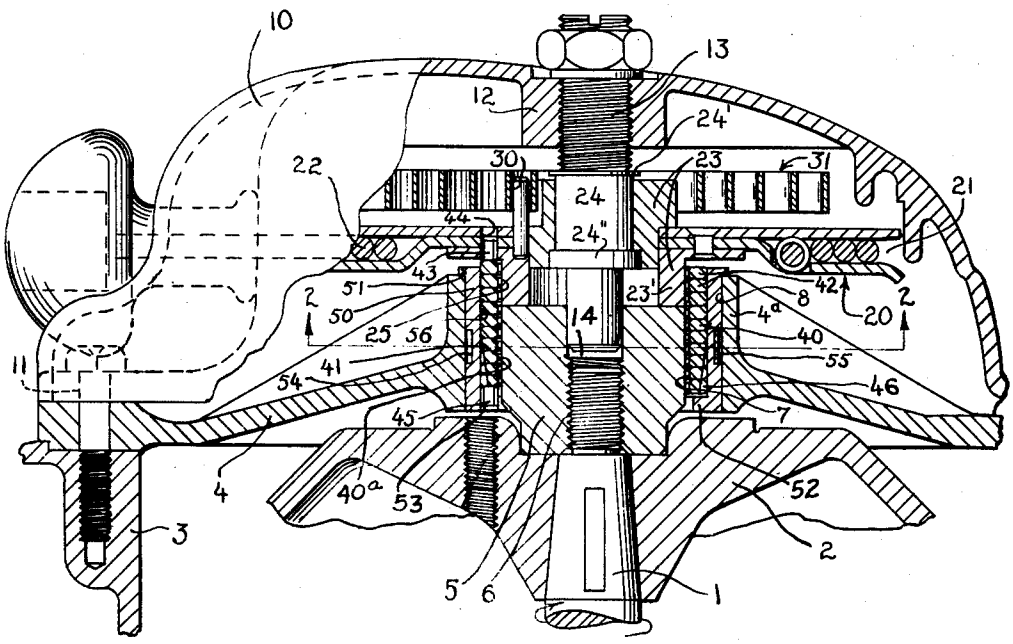


FIG. 1

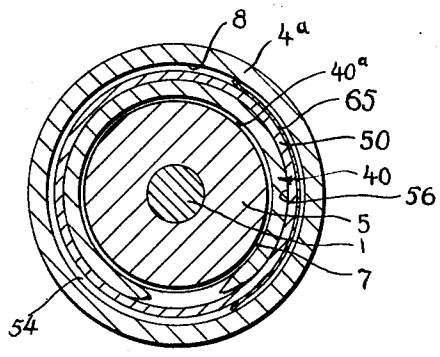


FIG. 3

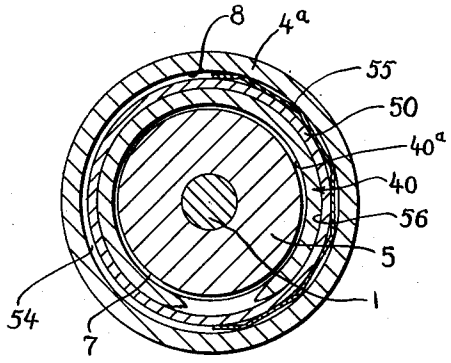


FIG. 2

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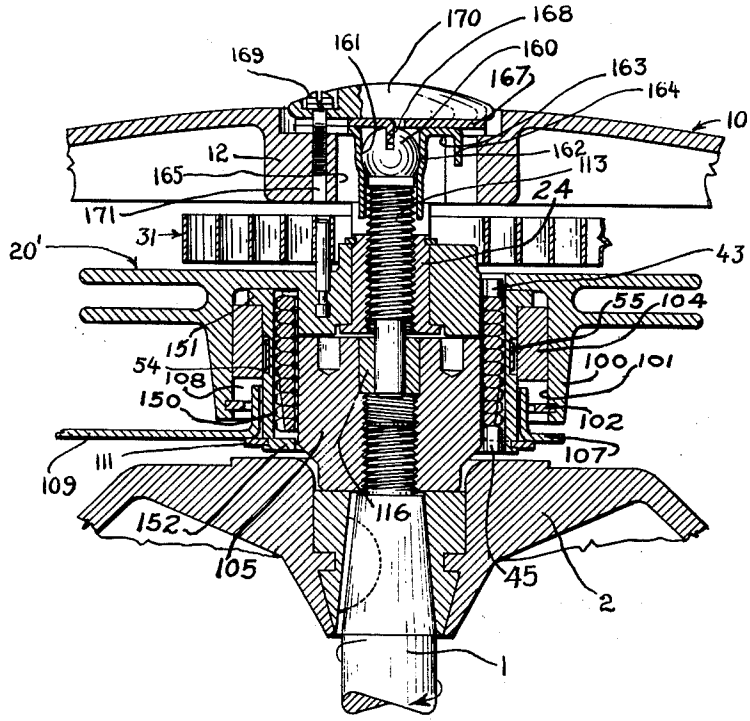


Fig. 4

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Patented June 20, 1950 2,511,908

UNITED STATES PATENT OFFICE

2,511,908

ENGINE STARTER UNIT

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Application October 29, 1947, Serial No. 782,922

8 Claims. (Cl. 192—42)

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This invention relates to a spring clutch device designed to provide, for example, an improved mechanism for effecting manual starting of internal combustion engines of the type used on small motor-boats and power machinery such as lawn-mowers, cultivators, and the like, thus indicating the general object hereof.

Another object is to provide a simple and effective one-way driving and two-way overrunning clutch mechanism.

Hand starter mechanisms of the type shown hereby comprise a drive wheel which may be in the form of a sheave for a starting cord or chain or may be a pinion in mesh with a starter gear sector adapted to turn the engine crank shaft. The wheel has a one-way driving (e. g. ratchet) connection with the crank shaft for rotation thereof in the engine starting direction only; and, in more modern types, there is a retriever spring for the wheel to return the cord, chain or other operating means to initial position. The present invention resides principally in the illustrated clutch arrangement for associating the starter wheel with the engine crank shaft while enabling the crank shaft to overrun the wheel as the engine starts and to become instantly released from the wheel in the event of engine backfire, and also to allow free return of the wheel to initial position after each operation thereof. The above indicates further objects hereof.

Other objects include provision of a self-releasing overrunning clutch mechanism, particularly for engine starting purposes, wherein the mechanism is a self-contained clutch unit adapted to be positioned and/or supported on its working axis wholly by the shaft (e. g. engine crank shaft) with which the unit is associated, this phase of the invention including a simple and effective means for adjusting the clutch mechanism unit along the axis of such shaft to proper operating position and locking it firmly in such position by readily accessible and easily manipulatable means.

The invention further includes a special adaptation of the clutch unit, according to the object just outlined, for light duty internal combustion engines (e. g. outboard marine type) wherein certain necessary force reactance portions of the unit may be secured to the engine housing by light weight and simple attachment means requiring no precision connections with such housing.

The present application is a continuation-in-part of my prior application, Serial No. 743,252 filed April 23, 1947, which application has been abandoned in favor of the present one.

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Other objects and features of the invention will become apparent from the following description of the preferred forms shown in the drawings.

In the drawings, Fig. 1 is a central sectional assembly view of an engine showing only a portion of the engine housing and crank shaft with the starting mechanism hereof, in one form, mounted thereon. Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1. Fig. 3 is a sectional view similar to Fig. 2 illustrating a modified form of friction spring. Fig. 4 is a central sectional assembly view of a modified form of the starting mechanism hereof.

Referring more particularly to Fig. 1, the crankshaft 1 has a keyed attaching taper for mounting a flywheel 2 thereon. The engine housing embodies a flanged portion 3 upon which is mounted an inner cover plate or spider member 4, having a flanged hub portion 4a, and concentric of the crankshaft 1. An attaching nut 5 is threaded to the top end of crankshaft 1, as at 6, forming a part of the starter clutch mechanism. The nut 5 may have top spanner sockets or other suitable means for engagement with a wrench. The nut 5 has a smooth, hardened cylindrical drum surface 7 which extends upwardly within a smooth internal drum surface 8 formed in the hub portion 4a of plate 4. These opposing radially-spaced drum surfaces 7 and 8 are concentric with the crankshaft.

Mounted above and upon the plate member 4 is a hood or housing cap 10, secured to the engine housing by bolts 11 or other suitable means. A central boss portion 12 of the hood rigidly and adjustably carries a vertical pilot stub shaft or pin 13, the lower reduced end of which freely enters a socket 14 formed in the top surface of the nut 5. The starter wheel 20 is in the form of a sheave having a peripheral slot 21 to receive a pull cord or cable 22 which extends outwardly through a suitable aperture (not shown) in the housing cap 10 and terminates in a suitable grip or handle. The wheel has a hub portion 23, the upper main part of which is centrally apertured to receive the pilot stub shaft or pin 13, the latter being mounted in said aperture on a bearing bushing 24 (cf. Fig. 4, part 24). The bushing 24 is secured in place in the hub by a snap ring 24' and the bushing is internally threaded to the pilot stub shaft for vertical adjustment of the wheel by turning of the stub shaft as will be apparent. The bushing has a lower supporting shoulder 24'' engaging the wheel hub opposite

the snap ring 24'. A lower end member 23' of the hub 23 may rest upon the top surface of nut 5 in light running contact therewith as determined by the adjustment of the stub shaft.

The wheel hub part 23' provides a smooth, cylindrical hardened external drum surface 25 having approximately the same diameter as the drum surface 7 of the nut 5. Outwardly from the hub the wheel 20 is suitably formed to provide an attachment for a terminal eye 30 of a spiral retrieving spring 31 which has another terminal eye on its opposite end attached in any suitable manner (not shown) to the housing 10. The spiral spring 31 returns the wheel 20 and cord or cable 22 to initial inactive position after each starting operation.

Bridging and surrounding the drum portions 7 and 25 of the nut and starter wheel hub respectively is a coiled clutch spring 40 which is normally prestrained into an expanded condition such that the inside clutching faces 40a of the spring coils 41 which surround the drum 7 are maintained out of contact therewith. The coils 42 which surround the wheel hub drum 25 may be normally in tight engagement with said drum as a self-energizing torque-transmitting attachment or may be normally spaced therefrom; as desired. In lieu of such attachment, or in addition thereto, as a suitable means for positively connecting the clutch spring with the wheel so that the spring always turns therewith, the upper end of the spring may be formed into a toe 43 inserted into an axial opening 44 in the wheel 20.

Lying outwardly of the clutch spring 40 and supported for restrained rotation by the non-rotating drum surface 8 of the plate member hub 4 is an energizer member in the form of a sleeve 50 having a top flange 51 resting on the top edge of the plate member hub 4a. The sleeve 50 has a smooth external circular surface conforming to the drum surface 8 of hub 4a within which it is free to rotate. The lower end of the sleeve 50 has an inturned flange 52 providing an axial support for the spring 40 and is provided with a radial notch, as at 53 for receiving an energizer toe portion 45 of the clutch spring.

A peripheral slot 54 is formed in the outer surface of sleeve 50 for receiving a clutch-energizing friction means shown in Fig. 2 in the form of a generally curved leaf spring 55 of the "Marcel" or wave type. There may be more than one such spring per starter assembly and the design of spring may be modified as will be explained.

The inner cylindrical surface 56 of sleeve 50 retains the clutch spring against undesired outward uncoiling movement so that regardless of the amount of outward prestress in the clutch spring, the inner clutching surfaces 40a will be maintained very closely spaced radially with reference to the drum surface 7 at all times while the starter wheel 20 is not being operated and/or during normal operation of the engine. Thus the engine crank shaft is always free to turn by engine power in either direction without restraint by the clutch, yet the clutch is in readiness for immediate non-lagging operation by the wheel 20 in the starting direction of rotation thereof.

The spring member or members 55 located in the slot 54 of the energizer sleeve provides or provide a slight frictional drag thereon with relation to the inner surface 8 of the stationary hub member 4a, the amount thereof being predetermined and governed by the design and resistance to flexure on part of the spring employed.

The spring 55 instead of being of the "Marcel" or wave type may, alternatively, be a normally flat or somewhat bowed leaf spring which in operating position is arcuately flexed as shown at 65 in Fig. 3 to secure the desired frictional drag or braking action. The frictional drag exerted by the spring (55 or 65) should be always sufficient to energize the clutch but so limited as not to overcome the return pull exerted by the retriever spring 20 upon de-energization of the clutch spring and release of the engine shaft.

The clutch spring 40 is wound in a direction such that when the wheel 20 is turned in the necessary direction to start the engine, the restraint imposed on the clutching coils 41 through the intermediary of the spring 55, sleeve 50 and energizer toe 45 will cause the coils 41 to contract against the drum surface 7 progressively from the energizing end upwardly and along the spring. This clutch spring energizing principle is well known in spring clutches. The clutch is self-releasing (a) upon return rotation of wheel 20 by retriever spring 31, (b) upon overrunning of the engine shaft when the engine starts, and (c) as will be more fully explained, upon counter-rotation caused by backfire of the engine. When the clutch spring is in gripping position, the coils thereof are out of contact with the inner surface of the sleeve 50 and in contact with both the drum surfaces 7 and 25. One or more of the clutch spring coils adjacent the energizer toe 45 may be reduced in cross section, as by means of slotting at 46; to increase the flexibility, hence delicacy of operation of the energizing coil or coils.

Rotation of the wheel 20 in the starting direction (clockwise as viewed from the outer end of the crankshaft, in the structure illustrated) causes immediate gripping of the drum surface 7 so long as tension is maintained on the pull cord 22. As soon as the engine starts to operate under its own power, the drum surface 7 overruns the clutch spring, the latter being self-de-energizing due to the outward prestress in the coils 41 and inherent tendency of the clutch spring to release load in one direction.

When engine backfire occurs, an instantaneous torque is produced on the rotating clutch unit and starter wheel 20 in a direction contrary to the torque being exerted by the operator on the starter wheel, as through the cord or cable 22. An extremely strong operator is incapable of resisting the instantaneous jerk on the cable; and the resulting momentary slackening of pull by the operator is always of sufficient duration to enable the clutch spring to be de-energized, i. e., to expand to its normal prestressed condition out of gripping relationship to the drum surface 7 of the engine flywheel.

Fig. 4 illustrates a modified form of engine starting mechanism embodying the invention and in operation and general construction is similar to the form according to Fig. 1. Similar members and parts are identified by the numerals heretofore given, the differences in construction being pointed out and described below.

In the modified construction the starter wheel 20^2 and the clutch mechanism itself (except for the flywheel nut 105 which serves as the driven clutch drum) comprise a self-sustaining unitary assembly which is piloted for operating location solely by the crank shaft 1, but is readily and bodily movable for assembly and adjustment along the axis of the crank shaft. Attachment of the unit in operating position requires no precision machining operations in order to enable the engine and starter assembly to be substan-

tially completed with assurance that the principal clutch parts will be certain to be concentric as required and fully operable without strain or wear.

The wheel bearing bushing **24** (essentially the same as in the previously described construction) determines the plane of operation of the starter wheel through the connection of the bushing with the pilot stub shaft **113**. As shown the lower, pilot end, of the stub shaft enters a bearing bushing **116** fixed centrally in the nut **105**. The wheel in turn through a depending circular hollow skirt or flange portion **100** and inside lower snap ring **102** engaged in a peripheral slot intersecting the inner bore **101** of the flange, supports the working parts of the clutch unit. The bore **101** contains, for easy rotation therewithin, a ring or sleeve **104** having circumferentially spaced tongues **108**, the lower ends of which slidably rest on the snap ring **102**. The sleeve **104** is fixed against rotation to serve as a counterpart for the drum portion **4***a* of the plate or spider **4** of the previously described construction. In order to hold the sleeve **104** against turning relative to the engine housing a ring **107** having upstanding tongues mating with those of the sleeve **104** as splines extends upwardly within the skirt portion **100**. The ring **107**, below the skirt, has a radially extending arm portion **109** (partially shown) which may be secured in any suitable manner, not necessarily rigidly, to any appropriate part of the engine housing.

The top of the drum-forming ring or sleeve **104** supports the spring energizing and retaining sleeve **150** through contact with a top flange **151** of said sleeve; and preferably the flange slightly clears the adjacent overhanging wall or web of the wheel **20'** to avoid frictional contact with the wheel. The bottom of the spring retainer sleeve **150** is flanged inwardly at **152** to provide a bottom support for the clutch spring, the flange being apertured to receive the energizer toe **45** of the spring. The bottom peripheral surface of the sleeve **150** is grooved to receive a snap ring **111** for holding the reactance ring **107** and its arm **109** in operating position and out of contact with the engine flywheel. The spring retainer sleeve **150** is peripherally grooved to retain the drag spring **55** or **65** for operation as previously described and the clutch unit as a whole functions as does the unit of Figs. 1 to 3. The working parts are held concentrically of the crank shaft by their mutually telescoping arrangement as will be evident from Fig. 4.

For the purpose of adjusting the vertical position of the clutch unit and to provide a lateral support for the upper end portion of the stub shaft **113** the top end of the stub shaft has a spherical formation **160** generally complementary to a socket **161** in a tubular metal part **162** having a head or flange formation **163** with a rotation-preventing finger **164** thereon engaging a vertical slot in the bore **165** of the boss **12** of the cover cap **10**. Surmounting the flange **163** is a stub-adjusting plate **167** having a tongue and slot connection at **168** with the spherical formation **160**. The plate and flange may be secured together after assembly on the spherical end of the stub shaft, thus providing a universal adjusting head for said shaft.

After proper manipulation of the adjusting head assembly **162—168** to secure free and effective operation of the clutch unit the stub shaft is then locked in adjusted position as by a single screw **169** extending through an eccentric hole

in a decorative cover cap **170** through aligned radial slots in the flange **163** and plate **167** into threaded engagement, selectively, with one of a series of openings **171** (one shown) spaced circumferentially about the boss **12** of the cover, being located equal distances from the center of the boss. The adjusting and locking arrangement holds the top end of the stub shaft **113** firmly without imposing any bending strain on it, thus cooperating with the pilot bushing **116** in holding the wheel bushing **24** solidly in place. The only wear in the operation of the starter is between the bushing **24** and the starter wheel.

While the clutch spring as shown is of the internally gripping or contracting type, the arrangement of parts may be reversed so that the drum surface carried by the crank shaft lies outside the spring for expansion clutching action thereof, in which case the energizing element herein represented by the sleeve **50** would lie inside the spring against a suitable non-rotating external surface portion of the engine assembly with the friction spring **55** or **65** interposed therebetween.

I claim:

1. In a starter mechanism for an internal combustion engine having a drum member fastened to the engine crank shaft, a driving member coaxial with and rotatable independently of said drum member, said mechanism comprising an overrunning self-releasing friction clutch means operatively connected to the driving member and normally out of contact with the drum but arranged to engage the same for starting the engine, a rotatable clutch-energizing unit including friction-operated rotation-restraining means coaxially of said driving member, the restraining means of the clutch energizing unit becoming automatically operative to render the clutch means effective consequent upon the driving member being rotated in its engine starting direction, the driving member, energizing unit and clutch means being maintained concentrically of the crank shaft principally by a pilot connection between the driving member and the crankshaft.

2. In a starter mechanism for an internal combustion engine having a drum member arranged to turn the engine crank shaft, a driving member coaxial with and rotatable independently of said drum member, said mechanism comprising an overrunning self-releasing spring clutch means operatively connected to the driving member and normally out of contact with the drum but arranged to engage the same for starting the engine, a rotatable clutch-energizing and clutch spring-containing sleeve member coaxially of said driving member, a non-rotatable sleeve member telescoping the first mentioned sleeve member and forming a radial bearing support therefor, a peripheral channel in one of the sleeve members and a normally non-circular leaf spring supported in and principally by the defining walls of the channel and operative to render the energizing sleeve member effective when the driving member is rotated in the engine starting direction of rotation thereof.

3. A clutch device adapted for use in an internal combustion engine starter mechanism having a rotary driven drum member arranged to turn the engine crank shaft and a coaxial driving drum member rotatable independently of said driven drum member, said device comprising; a coiled clutch spring with coils embracing the driving drum member and anchored thereto at

one end of the spring, the latter having coils telescoping but normally out of contact with the driven drum, a clutch energizing member adapted to be supported for frictionally resisting rotation coaxially with said drum members by a non-rotary member, said energizing member being connected to an energizing portion of the spring in a manner to initiate gripping of the driven drum member by the clutch spring consequent upon rotation of the driving drum member in the engine starting direction of rotation thereof only.

4. A spring clutch device comprising a driving drum and a coaxial driven drum, both of circular cross section, means supporting said drums for rotation independently of each other, a coiled clutch spring telescoping both drums and drivingly anchored to the driving drum, said spring having clutching coils peripherally close to but prestressed out of clutching contact with the driven drum, an energizer sleeve of circular form around the spring, telescoping the same and supporting all the coils thereof which lie adjacent the driven drum concentric with the driven drum and out of contact therewith, said sleeve being connected with a terminal coil of the spring remotely of the driving drum, and non-rotary means continually frictionally restraining the energizer sleeve against free turning movement, whereby the sleeve acts to energize the spring into gripping contact with the driven drum when the driving drum is turned in one direction but the driven drum is free to turn in either direction unrestrained by the clutch.

5. A starter mechanism for an internal combustion engine having a crank shaft and supporting housing, said mechanism comprising a circular nut threaded on the free end of the crank shaft, a circular member connected with the housing in a manner to prevent the member from turning, said member lying in surrounding and spaced relation to the nut, a starter wheel having a circular hub portion extending approximately into abutment with the outer end of the nut, a coiled clutch spring bridging the hub portion and nut, said spring being connected at one end to the wheel to turn always therewith and having clutching coils prestressed out of clutching relation to the nut, and a sleeve frictionally mounted within said circular member and connected with the opposite end of the spring to energize the spring into clutching relation to the nut when the wheel is turned in the engine-starting direction.

6. A starter mechanism for an internal combustion engine having a crank shaft and supporting housing, said mechanism comprising a circular nut threaded on the free end of the crank shaft, a circular non-rotating ring connected with the housing surrounding and in spaced relation to the nut, a starter wheel having a hub portion extending substantially into abutment with the outer end of the nut and approximately of the same diameter as the nut, a coiled clutch spring bridging the hub portion and nut, said spring being co-rotatively connected with the wheel and having clutching coils prestressed out of clutching relation to the nut, a sleeve mounted within said circular ring and connected

with the opposite end of the clutch spring to energize said spring into clutching relation to the nut when the wheel is turned in the engine starting direction, and friction detent means between said sleeve and said circular ring lying and contained in a continuous peripheral groove in one of those elements for resisting rotation of said sleeve with relation to said ring.

7. A manual type starter mechanism for an internal combustion engine having a crankshaft and supporting housing, said mechanism comprising a rotatable starter member having a hub portion, a threaded stub shaft extending through the hub portion, a bearing sleeve for the starter member on the stub shaft threads and connected to the hub so that axial movement of the sleeve axially adjusts the hub in reference to the crankshaft, a pilot connection between the stub shaft and crankshaft so that the latter radially supports one end of the stub shaft, adjusting means on the housing connected to the stub shaft for holding it against turning, means providing a circular clutch drum surface co-rotative with the crankshaft, a helical clutch spring connected at one end with the starter member and surrounding but normally out of clutching contact with the drum surface, an energizer sleeve around the clutch spring and connected to its opposite end, and means supporting the energizer sleeve for rotation concentric with the clutch spring while frictionally restraining rotation of the sleeve to cause the clutch spring to grip the drum surface when the starter member is turned in the engine starting direction.

8. A starter mechanism for an internal combustion engine having a crankshaft and supporting housing, means providing a circular clutch drum surface on and concentric with the crankshaft, a stub shaft adapted for operative engagement with the crankshaft for radial support, means for connecting the stub shaft to the housing, a starter member rotatably carried by the stub shaft, a circular flange on the starter member concentric with the stub shaft, a circular drum member radially supported by the circular flange and adapted for connection to the housing for preventing rotation of the drum member, a helical clutch spring generally concentric with and normally out of contact with the drum surface of said first mentioned means but frictionally engageable therewith, one end of the clutch spring being co-rotative with the starter member in the engine-starting direction of rotation thereof, energizing means for the spring connected to its opposite end and operatively associated frictionally with the drum member for causing the spring to grip said drum surface of said first mentioned means and turn the crankshaft.

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