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ENGINE STARTER MECHANISMS

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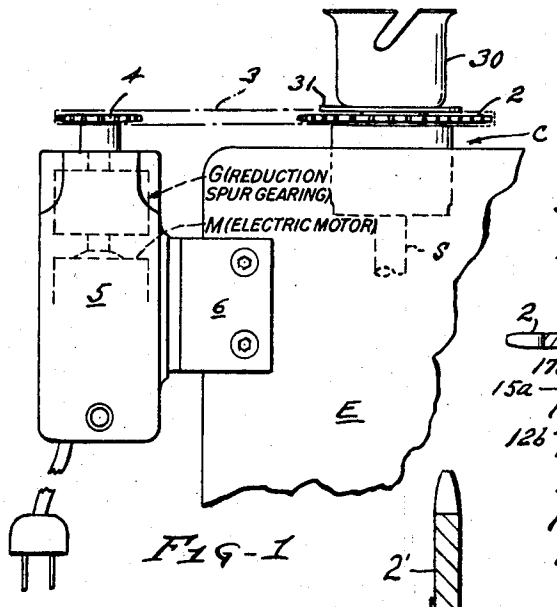


FIG-1

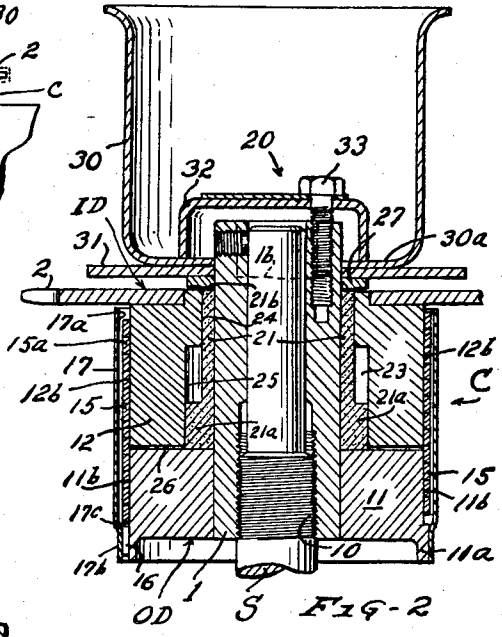


FIG-2

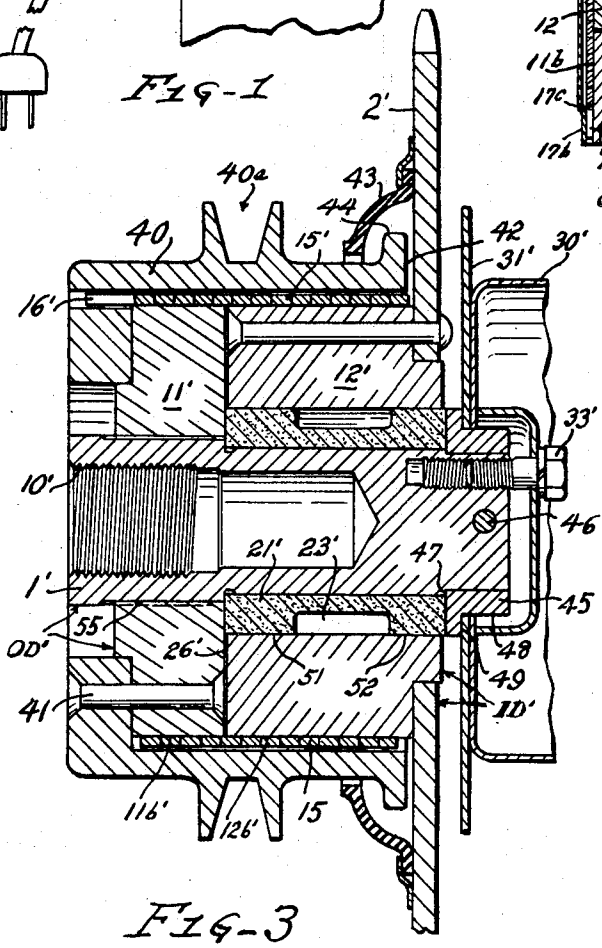


FIG-3

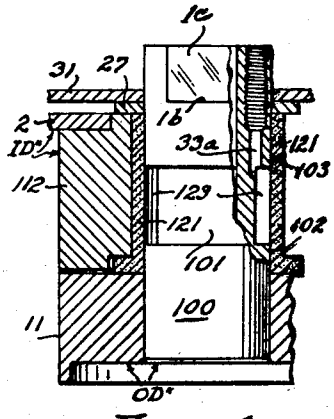


FIG-4

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ENGINE STARTER MECHANISMS

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9 Claims. (Cl. 74—7)

This application is a continuation-in-part of our application Serial No. 520,712 filed July 8, 1955, entitled Engine Starter Mechanisms. Said application is being abandoned.

The invention relates to an internal combustion engine starter including a self energizing helical spring or so called "coil" clutch, adapted to be operated by an electric motor and reduction gear unit designed to enable household electric service current for example to be used effectually and safely to start the engines. The herewith illustrated clutches are designed for starting relatively small engines such as commonly used on lawn mowers, motor boats and garden tractors. Two equally important requirements of electric motor driven starters in the above indicated type or class of service are low cost and reasonably long useful starter unit life despite expected occasional mishandling by persons having comparatively little mechanical aptitude or knowledge.

One reason there is a presently existing demand for electric power driven starters for small internal combustion engines which require no great amount of cranking torque for each cranking operation is that those engines are apt to require numerous starting turns of their crank shafts before they will commence normal operation. Thus, if only manual starter equipment is made available on the engines, the starting operations often deplete physical strength and/or patience on part of the user to the point of hazardous exhaustion.

One object of the present invention is to provide an electric starter, for the above indicated purposes, the electric motor of which can be connected to household supply current or other available current source and can safely remain in condition to furnish whatever number of successive starting impulses may be needed to start the engine. Stated another way, a specific object is to provide an electric starter the motor current supply cord of which may be plugged in at any convenient service outlet and be safely allowed to remain plugged in for a substantial period of time, even after normal engine operation has commenced.

Another object is to provide a starter spring clutch assembly for the above indicated purposes having an improved permanent lubricant supply for surfaces of the assembly which must be in running relative contact continuously during operation of the engine.

Other objects and advantages of the invention will be made apparent in the following description of the illustrative forms of starter mechanism hereof shown in the accompanying drawing, wherein:

Fig. 1 is a more or less diagrammatic, small scale fragmentary side elevation of the starter clutch mechanism mounted on an engine having a vertical crankshaft.

Fig. 2 is a full scale longitudinal central cross sectional view of the clutch mechanism partially shown by Fig. 1.

Fig. 3 is a view similar to Fig. 2 showing a relatively heavier duty engine starter clutch mechanism adapted to serve on an engine having a horizontal crank shaft.

Fig. 4 is a view generally similar to Fig. 2 showing a modified bearing and clutch drum construction.

In Figs. 1 and 2, an internal combustion engine the housing of which is partially shown at E, has its crank shaft S coupled directly to an output drum member OD comprising operatingly integral parts **1** and **11** of spring clutch assembly C. Part **1** is a shaft adapter tightly screw threaded as at **10** to an upper end portion of engine crank shaft S which has suitable bearing supports (not shown) in the ingine crankcase. The shaft adapter **1** is force fitted into drum part **11** of output drum member OD. The upwardly projecting portion of the shaft adapter **1**, beyond drum portion **11**, constitutes a journal support for the input drum member ID of the spring clutch assembly C comprising, as shown, operatingly integral parts **2**, **12** and **21**. Part **2** is a sprocket wheel rigidly secured to part **12** for driving the input drum member ID, part **12** is the clutch drum proper, and part **21** is a bearing bushing of oil absorptive metal construction force fitted into a bore **24** and a counterbore **25** of part **2** as will be further discussed later herein. The input and output drum members ID and OD are held in proper axial relationship by a fastening or clamping assembly **20** which includes removable threaded fastening screws **33** entering axial holes in shaft adapter part **1** as will be further described later.

As shown, in Fig. 1 only, the input drum member ID, represented by its sprocket **2** is permanently and positively connected through non-self-locking speed reducing transmission means to an electric motor M in housing **5** attached to the engine casing as by a bracket **6**. The speed reducing transmission, in case the electric motor is energized by battery current, hence has relatively low speed, may comprise only a sprocket chain drive, e. g. chain **3** connecting motor-connected sprocket wheel **4** with clutch input sprocket wheel **2** of suitably larger diameter than wheel **4** to afford for example a 4.8:1 reduction ratio. In the specifically illustrated arrangement, according to Fig. 1, housing **5** has additional speed reducing transmission means G of a non-self-locking type such as permanently intermeshed spur gearing between a high speed A. C. motor M and sprocket **4**, resulting in a total reduction of between 40:1 and 50:1. The reduction of speed through non-self locking gearing (as distinguished e. g. from worm gearing) is a shock absorption feature of the present mechanism which, as will be further explained, makes it possible and practicable to use a very simple overrunning, self energizing spring or coil clutch as the automatically actuated and released driving connection between the starter motor and the engine crank shaft. By appropriate design the output speed of the electrically driven mechanism (sprocket **2**) is considerably less than the minimum idling speed of the engine (circa 500 R. P. M.) or the lowest speed at which the engine will run under its own power.

The metal clutch drum parts **11** and **12** of clutch assembly C are approximate cylinders of equal diameter and one end of a clutch spring **15** can be anchored to drum part **11** as by an axially extending lug or toe **16** on the clutch spring, designed to freely enter an axial slot in a relatively enlarged rib portion **11***a* of drum part **11**. The spring coils adjacent toe **16** and the free end coils **15***a* are normally in interference fitting relationship to respective circular drum surfaces **11***b* and **12***b* of respective drum parts, particularly so that the clutch spring will be strongly self energizing in the clutching direction. The spring **15** is right hand coiled in case crank shaft rotation is clockwise as viewed from a point above the engine.

A generally cylindrical metal shell **17** having a main

inner diameter surface portion 17*a* about the spring coils somewhat larger than the normal outer diameter of the spring and another, smaller, inner diameter surface portion 17*b* tight around a rib portion 11*a* of drum part 11 as by a press fit. When portion 17*b* of the shell 17 is pressed onto rib portion 11*a* of drum part 11, an inner generally conical surface or radius portion 17*c* of the shell 17 serves as a guiding ramp or pilot surface. The clutch spring 15 is readily removable from its working position between drum part 11 and shell 17.

In making the clutch spring from generally rectangular spring stock the latter is "flat wound" or with its greater cross sectional dimension parallel to the coil spring axis rather than radial. Thereby the spring has a relatively high index and, concomitantly, relatively low static unit drum-surface-gripping pressure as compared to "upright wound" rectangular spring wire stock of adequate cross section. The wire stock for the clutch spring in the assembly according to Fig. 2 (having approximately 2½" diameter drum surfaces and a 708 pounds/inch torque requirement) is approximately 1/16" x 1/8" rectangular wire. This from the standpoint of torque is roughly equivalent to 3/32" square wire; but that wire would probably be too stiff for centrifugal release at low idling speed of the engine. In an assemblage such as shown, wherein the engine crank shaft is continuously coupled with the clutch spring, the latter (assuming it is sufficiently strongly self energizing in reference to the driving drum surface 12*b* of the clutch assembly) must be self releasing from that same drum surface (12*b*), in order to avoid destructive wear, while the engine crank shaft is turning at idling and all higher speeds. For self energization the clutch spring 15 has about a 1/32" interference fit on the drum surfaces, and the spring index is such that all or nearly all of the spring coils will be definitely released from their associated drum surfaces 12*b* and 11*b* by centrifugal force as soon as normal engine operation commences. The coils meanwhile are prevented from excessive expansion and, during engine operation at various working speeds, are held centered with the drum surface 11*b* and 12*b* by shell portion 17*a* which, as nearly as possible, is made concentric with the drum parts 11 and 12. It is, of course, only necessary for centrifugal clutch release that the spring coils around the input drum member surface portion 12*b* expand clear of that surface portion. The output-drum-member-associated coils of the clutch spring 15 could, as an alternate means of anchoring the clutch spring to the output drum member OD, have several times as much effective preloading on drum surface 11*b* as on surface 12*b*.

With the mechanism as thus far described it will be apparent that, when the electric motor of unit 5, Fig. 1, is energized, cranking of the engine is automatically accomplished and that, in event of initial "false start," further cranking will be effected so long as the electric motor continues to operate. Further, as soon as the engine commences to run under its own power, the clutch spring 15, first for an instant by overrunning on drum surface 12*b* and then by complete centrifugal release therefrom, permits the engine crank shaft to turn without restraint by the clutch mechanism and without danger of damaging the clutch. In event of engine backfire the clutch spring becomes suddenly subjected to greater torque than is normally required to turn the crankshaft in the starting direction, but the non-self locking, speed reducing transmission means (sprocket and/or spur gearing) then acts as a cushion or shock absorber during the relatively short period the backfire-imposed torque remains seriously effective. The yielding has been found sufficient in all cases to prevent damage to the clutch spring or the drum surfaces frictionally engaged by it notwithstanding the fact that the clutch spring 15 (for the sake of high index and the rest as already explained), is purposely designed somewhat undersize (radially of the spring) in relation to normally required torque.

Special provision is made in order to assure a gradually dispensed supply of lubricant to the mutually contacting surfaces of oil absorptive bushing 21 and the shaft adapter 1. When the drum part 12 is made of solid i. e. nonporous, metal such as steel or aluminum an advantageous construction is as follows: Annular open space 23 in drum part 12 around the bushing 21 constitutes an oil reservoir which can be fully charged with oil and sealed by the bushing during the process of pressing the bushing tightly into the bore 24 and counterbore 25 of the drum part 12, providing the space 23 is suitably vented as by a small axial or radial hole in one of the components (hole not shown) which can, after assembly as by press fitting, be suitably plugged either permanently or with provision enabling refill of the reservoir. The bushing 21 and its flange 21*a* form oil absorptive or receptive wall portions of the reservoir, the remainder and mainly radially outward non-oil-absorbing wall surfaces being defined by portions of counterbore 25 in drum part 12 as will be evident. The use of bushing flange 21*a* as one wall of the oil reservoir avoids having to form an internal undercut in the drum part 12, which undercut would be quite expensive. Since the input clutch drum member ID is rotated only during starting of the engine, the oil in the reservoir 23 is subjected only occasionally to centrifugal force, and, because the oil can leave the reservoir only through the pervious material of the bushing 21 the supply is unlikely to become depleted during the life of the clutch.

Fig. 4 shows an alternate design wherein the lubricant reservoir 123 is formed as an external peripheral groove 101 in a modified shaft adapter 100. The bushing 121 in that case is of more or less conventional form and is pressed over uniform diameter circular surface portions of the shaft adapter so that parts 11, 100 and 121 constitute the operatingly integral components of output drum member OD" on which the input drum member ID" is journalled for free rotation, as is necessary when the spring clutch mechanism hereof is released. Because the output drum member OD", hence the oil reservoir 123, must be turned at whatever speed the engine crank shaft turns, during normal operation of the engine, the oil in reservoir 123 is much more apt to become depleted than is the case with the Fig. 2 construction. Provision for refill of the reservoir 123 comprises, as shown, a lubricant passage 33*a* intersecting an axial wall of the reservoir. Said passage, conveniently, is formed as an extension of one of two threaded axial holes for reception of the screws 33 of clamping assembly 20. The outer end of the passage 33*a* is rendered accessible for recharging the reservoir by removing the associated screw 33 which normally plugs the passage.

Referring further to Fig. 2, partly in order to insure maintenance of a desirably small but permanent clutch spring crossover gap at 26 (i. e. to avoid wearing of the juxtaposed surfaces of the two clutch drum parts 11 and 12), the bushing 21, which is axially fixed in drum part 12 as already described, is made slightly longer than the maximum axial dimension of the drum part 12, and the bushing flange portion 21*a* projects slightly below the lower face of part 12. The upper end face 21*b* of the bushing is preferably flush with the adjacent upper end face of the drum part 12. A bronze thrust washer 27 lies between the mutually flush surfaces just mentioned and a circular disc 31 (rope guard, described below), and the disc 31 is prevented from becoming forced against the top face of thrust washer 27, when fastening or clamping assembly 20 is tightened, due to the fact that the under face of disc 31 is forced against a pair of axial shoulders 1*b* (one shown in Fig. 4) on shaft adapter 1 by the clamping assembly 20. Upwardly beyond the shoulders 1*b* the shaft adapter has parallel flats 1*c*, and the central hole in disc 31 conforms generally to the flattened end portion of the shaft adapter.

Auxiliary cranking or starter cup 30 (for a rope, not

shown) has a hole in its bottom wall 30*a* mating the flats 1*c* of the shaft adapter as a spline connection therewith, and the fastener assembly 20, shown as comprising an inverted steel cup 32 and the screws 33, one shown, removably holds the auxiliary starter cup and its rope guard disc 31 tightly on the shaft adapter.

In the heavier duty starter clutch construction, such as shown by Fig. 3, the parts corresponding essentially to those already described are identified by the same reference characters as used in Fig. 2, but primed.

In place of the shell 17 of Fig. 2 a hollow tubular casting 40, serving in part as a power take off through pulley formation 40*a*, is secured as by rivets, one shown at 41, to the clutch drum part 11' around clutch spring 15'. Since the right hand end of tubular casting 40 must be spaced from the sprocket wheel 2', as at 42, an annular rubber weather shield is provided at 43 to cover the gap 42, particularly when the clutch assembly is to be used out of doors in its illustrated horizontal position. During assembly of the clutch, the shield 43 is expanded over a flange portion 44 of tubular casting 40.

The oil absorptive bronze bushing 21' of Fig. 3 has an external peripheral groove or channel formed in it to provide the principal defining walls of lubricant reservoir 23', and the circular surface portions 51 and 52 of the bushing 21' are force fitted into a uniform diameter axial bore of drum part 12'. The left end of the bushing 21' normally abuts a shoulder on a relatively enlarged diameter portion of the shaft adapter 1' to preserve a proper spring crossover gap at 26'. A bronze ring 45 which serves as a thrust washer, shown pinned to the shaft adapter 1' at 46, abuts a shoulder 47 on the shaft adapter in order to preserve axial working clearance (not shown) between the ring 45 and the right hand end surface of bushing 21'. The reduced surface portion 48 of ring 45 is non-circular for engagement with a mating hole in the bottom of starter cup 30'. The press fitting between output drum member part 11' and the shaft adapter 1' is preferably reinforced by serration splines at 55 formed on the shaft adapter which is made of steel, whereas drum part 11' is of soft metal. It will be apparent that in Fig. 3 the parts defining or constituting the oil reservoir 23' rotate only during the engine starting operation.

The operation of the Fig. 3 construction is the same as that of Fig. 2 in all respects.

We claim:

1. An internal combustion engine starter mechanism comprising an electric motor, a spring clutch unit having concentric input and output external drum members axially adjacent to each other, means torque-connecting the input drum member to the electric motor in a manner to be turned thereby at a lower speed than the minimum speed the crankshaft can turn when the engine is self operated, means permanently connecting the output drum member with the engine crankshaft so as to turn at whatever speed the crankshaft turns, a contracting-to-grip clutch spring having free end coils in interference fitting, hence self energizing, relationship to an external peripheral surface portion of the input drum member, the spring being permanently anchored to the output drum member, and the clutch spring having such spring index as to be automatically released from said input drum member surface portion by centrifugal force when the engine is self operated and its crank shaft is turned thereby at said minimum speed or at higher speeds.

2. The engine starter mechanism according to claim 1, wherein the input drum member of the spring clutch unit is continuously positively connected to the electric motor through speed reducing, non-self-locking transmission means, whereby, in event of engine backfire, the input drum member of the clutch is restrainedly permitted to turn and relieve the clutch spring of some of the shock loading which tends to occur incident to such engine backfire.

3. The engine starter mechanism according to claim 1, wherein the clutch spring is made from spring metal of elongated generally rectangular cross section, the spring stock being wound flat or having the longer cross-section-defining dimension of the spring stock extending axially of the spring coils.

4. In combination with an internal combustion engine having a crankshaft and an electric motor adapted to turn the crankshaft and start the engine, a starter clutch comprising coaxial input and output external clutch drum members and means respectively connecting the drum members permanently to the electric motor and the engine crankshaft, a helical clutch spring permanently connected to turn with the output drum member and having free end coils around and yieldably tight on the input drum member and so designed as to be expanded centrifugally by operation of the engine crankshaft at engine starting, idling speed, a tubular bearing bushing of oil absorptive material in rotation-guiding, sliding peripheral contact with one of the drum members and in forced fitting, fully mating, telescoped relationship to axially spaced apart circular surface portions on the other of the members, said other member being, in effect, relatively undercut axially between said surface portions to provide, radially adjacent the bushing, a generally sealed annular storage reservoir for lubricant in contact with the bushing.

5. An electric motor operated starter clutch mechanism for internal combustion engines and comprising coaxial input and output external clutch drum members adapted to be connected respectively to an electric motor and an engine crankshaft, a helical clutch spring permanently connected to turn with the output drum member and having free end coils around and yieldably tight on an external circular surface portion of the input drum member, said free end coils being designed to be expanded centrifugally by operation of the engine crankshaft during self operation of the engine, a tubular bearing bushing of oil absorptive material in rotation-guiding, sliding peripheral contact with one of the drum members and in forced fitting, fully mating, telescoped relationship to axially spaced apart circular surface portions of the other of the members so as to be operatingly integral with said other of the members, said other of the members being in radially spaced relationship to the bushing between said surface portions to provide, with the bushing, a generally sealed annular storage reservoir for lubricant.

6. The mechanism according to claim 5, wherein the bushing and all surfaces defining the lubricant reservoir are fixed portions of the input drum member, so that the lubricant in the reservoir is normally subjected to centrifugal force when and only when the input drum member is being rotated by the electric motor to start the engine.

7. An engine starter spring clutch mechanism according to claim 5 further characterized in that the input clutch drum member is journalled for free rotation on the output drum member and is supported thereby through the intermediary of a bearing bushing of oil absorptive material in fully mating tight peripheral contact with axially spaced apart circular surfaces of a portion of the input drum member to provide, in conjunction with an axially intermediate surface portion of that drum member, radially spaced from the bushing all around the common axis of rotation of the drum members, a sealed annular lubricant reservoir which is rotated only when the input drum member is rotated.

8. The mechanism according to claim 5, wherein the lubricant reservoir is defined, in part, by an external peripheral groove in a portion of the output drum member, and the bushing telescopes the groove in forced fitted relationship to external circular surfaces of said portion of the output drum member, and said portion has an axial lubricant introduction passage one end of which intersects one wall portion defining the reservoir and the

opposite end intersecting an axial end surface of said portion of the output drum member.

9. The starter mechanism according to claim 5 wherein the lubricant reservoir is partially constituted or defined by a circular axial counterbore in one of the drum members, that drum member having a coaxial bore in interference fitted relationship to an external surface of a relatively smaller diameter portion of the bushing and the counterbore surface being in tight lubricant sealing relationship to a relatively larger diameter external peripheral surface portion of the bushing in axially spaced relationship to the bottom or axial terminus of the counterbore.

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