Jan. 13, 1959 W. H. SCHNACKE 2,868,186

INTERNAL COMBUSTION ENGINE STARTER

Filed April 1, 1954 3 Sheets-Sheet 1

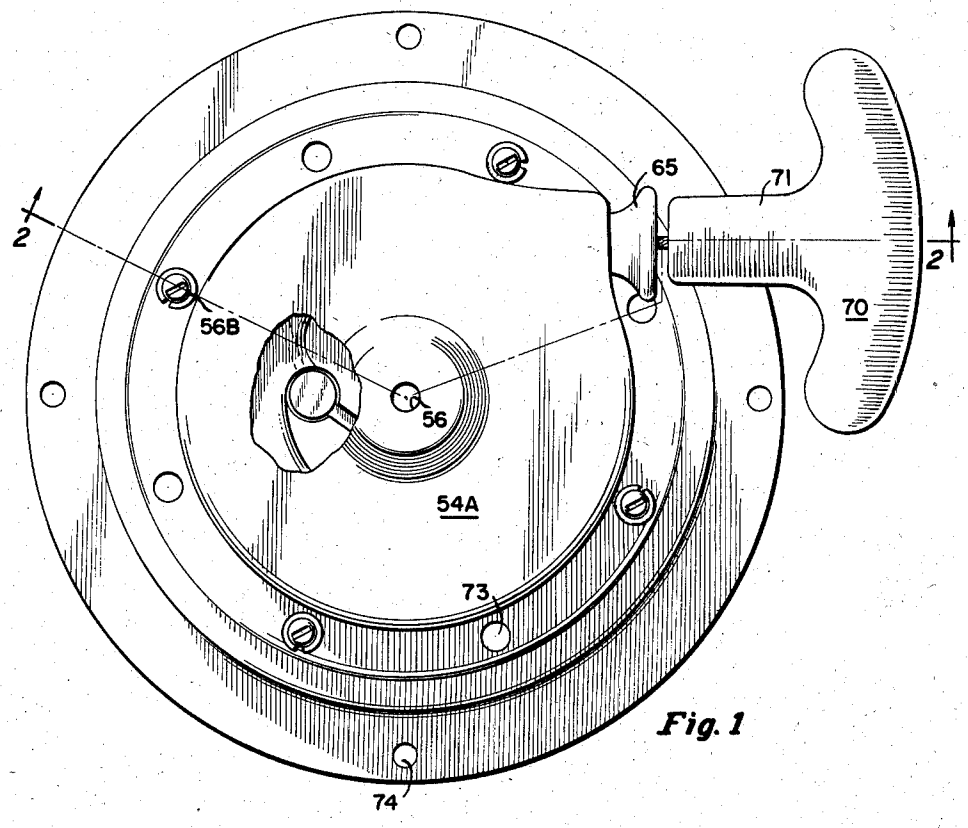


Fig. 1

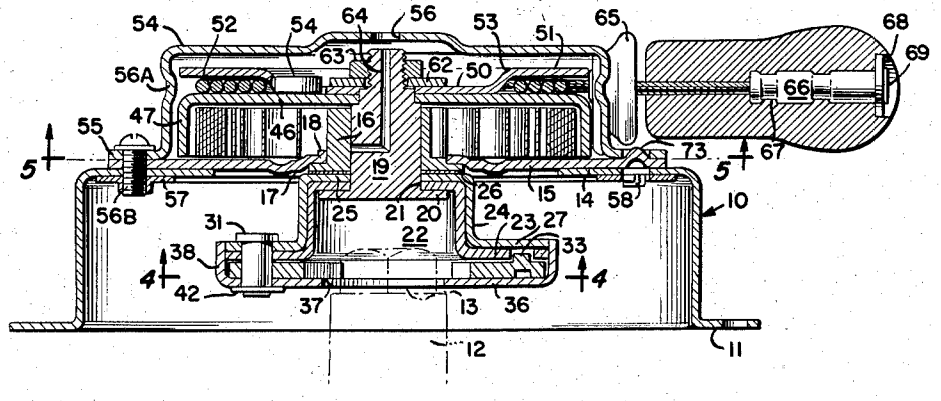


Fig. 2

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INTERNAL COMBUSTION ENGINE STARTER

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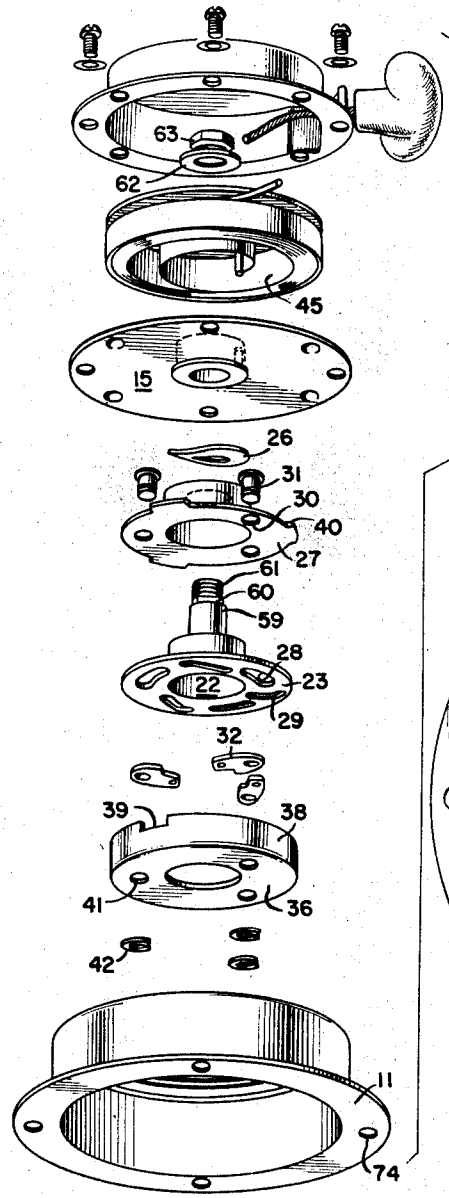


Fig. 3

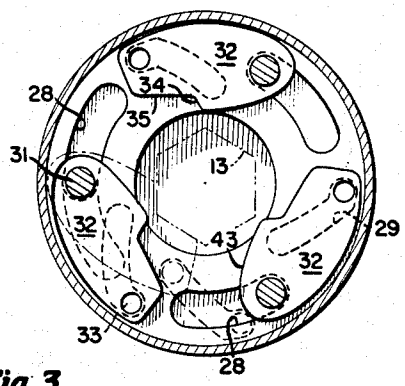


Fig. 4

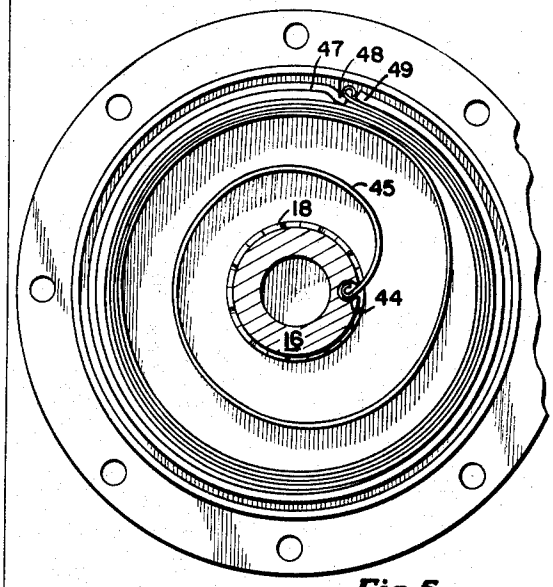


Fig. 5

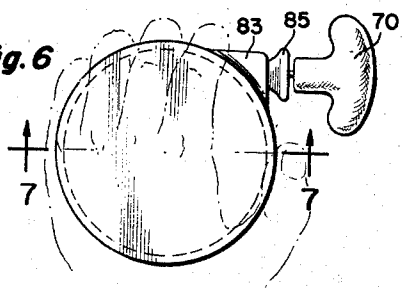


Fig. 6

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INTERNAL COMBUSTION ENGINE STARTER

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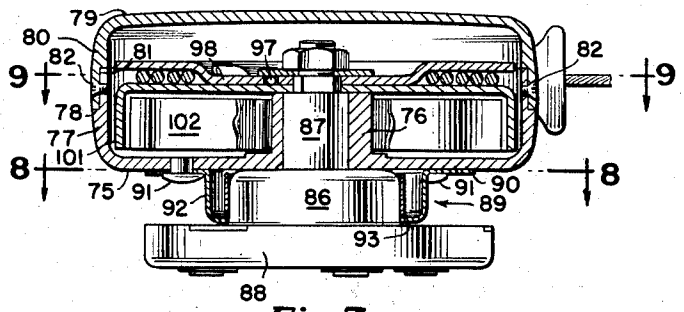


Fig. 7

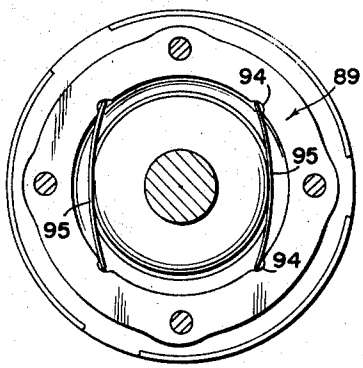


Fig. 8

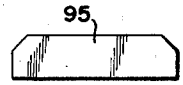


Fig. 11

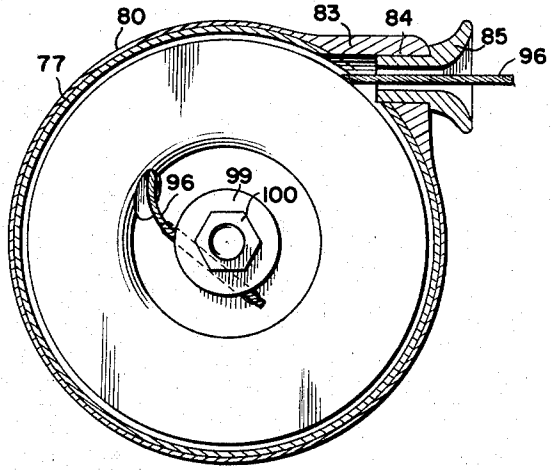


Fig. 9

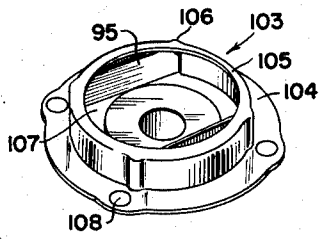


Fig. 10

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INTERNAL COMBUSTION ENGINE STARTER

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Application April 1, 1954, Serial No. 420,387

18 Claims. (Cl. 123—185)

The present invention is an improvement over Patent 2,604,882 and relates to apparatus for producing rotary motion in one direction and more particularly relates to structure for starting internal combustion engines of the type used for outboard motors, lawn mowers, and the like.

Various types of ratchet mechanisms, cranks, drums, and cable mechanisms have been used for cranking internal combustion engines, but these devices have not been entirely satisfactory. The prior starting mechanisms were necessarily fixed to the motors, and, particularly in the types using ratchet teeth on the ends of sleeves, accurate axial and radial location of the sleeves was essential for proper operation.

Further, the prior devices were not satisfactory because of the manufacturing complications and installation difficulties. The difficulty of assembly and the problem of obtaining the proper frictional resistance for the operation of the ratchets of the prior art could not be accomplished without great expense requiring highly skilled labor.

It is an object of the present invention to overcome the difficulties encountered with the prior starting devices.

A further object is to provide a starter which cooperates with the circumference of a relatively elongated polygonal nut so that it is unnecessary to accurately locate the starting device in an axial direction.

A further object is to provide a starter which will automatically center itself on the motor with which it is used.

Another object is to provide a portable starting device which may be used with any one of a number of motors thereby reducing the weight of the motor and simplifying the manufacture and maintenance thereof.

Another object is to provide a cable actuated starting device in which the cable remains accurately within a reel.

Another object of the invention is to provide a structure in which many of the same parts are used for clockwise or counter-clockwise rotation, thereby greatly reducing inventory and manufacturing costs.

Referring more particularly to the drawings:

Fig. 1 is a plan view of the starter showing the reel and spring housing and the supporting structure for attachment to a motor;

Fig. 2, a section taken on the broken line 2—2 of Fig. 1;

Fig. 3, an exploded view showing the parts separated but in positions to indicate the order of assembly;

Fig. 4, a section on line 4—4 of Fig. 2, showing the ratchet mechanism in its inoperative position with a dot-dash line showing of the one ratchet key in the operative position and a dot-dash line showing the cam slot for the one key;

Fig. 5, a section taken on line 5—5 of Fig. 2, illustrating the attachment of one end of the clock type spring to the bearing and the other end of the spring to the retaining barrel;

Fig. 6, plan view of an alternate form of housing for the spring and cable;

Fig. 7, a section similar to that of Fig. 2 of the modification taken substantially on line 7—7 of Fig. 6 and showing the housing for grasping by a person's hand;

Fig. 8, a section taken on line 8—8 of Fig. 7 showing the retainer for the leaf springs with the leaf springs in engagement with the outer clutch element;

Fig. 9, a section taken on line 9—9 of Fig. 7 showing another manner of attaching the cable to the reel;

Fig. 10, a perspective of the leaf spring holder as applied to a bearing plate of the type shown in Figs. 1 to 5 inclusive; and

Fig. 11, an elevation of a leaf spring for frictional engagement with the outer clutch element.

Briefly stated, the present invention includes a cylindrical supporting housing for attachment of the lower end thereof to a motor and a bearing plate secured to the upper end of the housing and carrying a bearing centrally thereof. A shaft having a flange at its lower end is rotatably mounted in said bearing. A first member having a hollow cylindrical portion with an inwardly extending flange at its upper end and an outwardly extending flange at the lower end is fixed to the shaft flange by the inwardly extending flange being spot welded or otherwise fixed to the upper surface of the shaft flange. A second member having a hollow cylindrical portion and an inwardly and outwardly extending flange is mounted on the first member so that the first member rests within the second member for relative rotative movement. The outwardly extending flange of the first member is provided with spaced arcuate slots and pins extend through apertures in the outwardly extending flange of the second member and through the arcuate slots of the outwardly extending flange of the first member, thereby permitting limited rotative movement of the members. Cam slots are provided between the arcuate slots in the outwardly extending flange of the first member. Keys having upwardly extending lugs formed by a punching operation are pivotally mounted on the pins below the outwardly extending flange of the first member with the lugs extending into the corresponding cam slots so that relative movement of the first and second members causes the keys to pivot about their supporting pins.

Each key has an abutment shoulder for turning engagement with a nut and has a guide edge for properly positioning the shoulders on the nut on the shaft to be rotated. A friction spring is provided between the second member and the bearing to prevent undesired rotation of the second member.

Upon the upper end of the shaft a spring receiving barrel open at the bottom has its head fixed to the shaft and a spiral spring is secured at its inner end to the bearing and its outer end to the periphery of the barrel for produring torque in one direction on the shaft. A reel plate on the upper side of the barrel head forms a cable receiving space by the reel plate having its outer periphery offset with relation to the central portion for receiving spiral convolutions of a cable. A cable is attached to the reel plate by means of an aperture formed in the central portion of such reel plate and a pivot pin fixed to the inner end of the cable is pivotally mounted on the aperture.

A reel housing having a portion of generally cylindrical shape with an outwardly extending lobe of substantial size is mounted on the bearing plate and the cable passes through the lobe and a handle is fixed to the outer end of the cable by means of a bore through the handle and a crimped sleeve and washer in the handle bore.

Referring more particularly to the drawing, a hollow supporting foraminous cylindrical housing 10 is provided with an outwardly extending flange 11 at its lower edge for securement to a motor frame or the like. A motor shaft 12, shown in phantom, carries a nut 13 also shown in phantom. The supporting housing 10 is perforated in

the cylindrical portion thereof to reduce weight and to permit ventilation and is provided with an inwardly extending flange 14 on which a bearing plate 15 is mounted.

A bearing boss 16 having a flange 17 on its lower end engaging the lower surface of the bearing plate 15 passes through a central aperture in the bearing plate 15 and is secured thereto by a shoulder 18 on the bearing boss being swaged to overlie the upper surface of the plate 15, thereby maintaining the bearing boss 16 in assembled relation to the bearing plate 15.

A stub shaft 19 provided with a flange 20 at its lower end is secured by spot welding or the like to an inwardly extending flange 21 of a first clutch member 22 which also includes a hollow cylindrical portion and an outwardly extending flange or disk 23. A second clutch member 24 of hollow cylindrical shape has an inwardly extending flange 25 overlying the flange 21 and an outwardly extending flange or disk 27 overlying flange 23 and is rotatably mounted on shaft 19 and nestingly receives the first clutch member 22. A spring washer 26 of the warped or corrugated type is positioned between the lower end of bearing 16 and the inwardly extending flange 25 of the second clutch member 24 for applying a frictional force therebetween to retard rotation of the second clutch member 24.

The flange 23 of the first clutch member is provided with arcuate slots 28 and cam shaped slots 29 while the corresponding flange 27 of the second clutch member is provided with apertures 30 for registry with the arcuate slots 28 and removable headed pins 31 pass through the apertures 30 and through arcuate slots 28. Upon the downwardly projecting ends of the pins 28 keys 32 provided with upwardly extending lugs 33 which are received in cam slots 29 are mounted for relative rotation of the first and second clutch members for causing the keys 32 to move from the full line position shown in the drawings to the dot-dash line position shown for the one key in the lower left portion of Fig. 4. The arcuate slot and the cam shaped slot for the one key 32 at the lower left of Fig. 4 are shown by dot-dash lines in the inner position. It will be understood that the other keys are similarly moved inwardly. The keys are provided with a shoulder 34 for engaging and rotating the nut and with a guiding surface 35 for positioning the key relative to the adjacent wrenching surface of the nut 13.

For maintaining the first and second clutch members and the keys in operative position, a retaining disc plate 36 having a central aperture 37 for receiving the nut 13 is provided with an upstanding circumferential flange 38 for surrounding and receiving the flange 27 of the second clutch member. The flange 38 has notches 39 for receiving lugs 40 projecting outwardly from flange 27 to prevent relative movement of the retaining plate 36. The pins 31 also pass through apertures 41 in the retaining plate and are secured against removal by means of horseshoe shaped spring washers 42 received in circumferential grooves at the lower ends of pins 31 in a conventional manner thereby retaining the clutch members, the keys, and the retaining plate in assembled operative relation. The flange 14 of the supporting housing is of a size to permit disc plate 36 to pass therethrough thereby simplifying the assembly of the starter.

From the above it will be evident that upon viewing the structure as shown in Fig. 4 and assuming that the shaft 19 will be rotated counter-clockwise, the first clutch member 22 will be rotated counter-clockwise and arcuate slots 28 will permit the clutch member 22 to rotate relative to clutch member 24, clutch member 24 being retained from rotation by friction disc 26. Lugs 33 of the keys or pawls 32 will be moved toward the axis of shaft 19 by the cam grooves 29 as such cam grooves move in the counter-clockwise direction to the dot-dash line position. Further rotation of shaft 19 and clutch member 22 may cause the lugs 33 to engage the inner ends of the cam slots 29 thereby causing the shoulders 34 and 35 to engage the adjacent wrenching and guiding surfaces of the nut 13. The lugs 33 may not engage the inner ends of the cam slot 29 and a continuous pressure will be applied by the camming action urging the keys 32 inwardly and maintaining a clamping action on the nut 13.

It will be noted that the shape of the cam slots 29 are generally spiral and the pawls are positively retained in their retracted positions and in their operative positions by the shape of such spiral cam slots 29. The length of the pawls or keys 32 and the intermediate positions of the shoulders 34 on the pawls provide for a desired positive action in which it will be noted that the parts form, in effect, a toggle retaining the pawls in their positions due to the shape of the spiral slots 29.

As soon as the engine is started, the counter-clockwise rotation of the nut 13 as viewed in Fig. 4 will cause the keys to be pushed outwardly by engagement of the corners of the nut with the rounded surfaces 43 of the keys 32. The keys will be retained in their outer position by the friction washer 26 which frictionally prevents relative rotation of the clutch member 22 and the clutch member 24. The release of the handle 70 will permit spring 45 to rewind the cable and cause shaft 19 to rotate clockwise thereby causing clutch member 24 to have relative movement with respect to clutch member 22 and the keys 32 will return to the full line position.

A dove-tail type channel 44 is formed in the wall of bearing 19 outwardly of the bearing surface so that an edge of channel 44 breaks out through the periphery of the bearing for receiving the enlarged inner end of a spiral spring 45. The spring 45 is mounted within a barrel formed by an upper plate 46 providing the head and a peripheral flange 47, such barrel being open at the bottom. The periphery 47 of the barrel is provided with a slot and a portion of the material is struck inwardly at 48 to a substantial extent and the other side of slot is formed by an instruck portion 49 so that the outer enlarged end of the spiral spring 45 may be retained in the slot.

Secured to the upper surface of the barrel head 46 is a reel disc having a central circular portion 50 fixedly secured to the head 46 by spot welding or the like and said reel disc includes an offset outwardly extending flange portion 51 which provides a spacing between such flange portion 51 and the head 46 to receive a single coil of a cable 52 so that each turn of the coil of the cable lies upon the coil therebelow without binding and the offset portion 53 between central portion 50 and flange 51 serves as the drum on which the cable 52 is wound. For securing the cable to the drum, a peripheral portion of the central portion 50 is offset slightly adjacent the offset portion 53 and an aperture extends therethrough. A large diameter cylindrical pin member 54 is pivotally received in such aperture and the inner end of the cable 52 passes through a transverse aperture in the cylindrical pin member 54 and is held therein by riveting, swaging, welding or the like or combinations thereof.

Upon reference to Fig. 1, it will be noted that the cable extends substantially tangentially to the offset portion 53 so there is no appreciable tendency for the cable to unwind unless a pull is exerted thereon, and the pivotal mounting prevents objectionable bending of the cable. A reel and spring housing 54A includes a cylindrical portion open at the bottom with an outwardly extending flange 55 having a plurality of apertures therethrough, the top of the housing 54A being closed and provided with a central opening 56 for oiling the interior. The cylindrical portion of the housing 54A is provided with an inwardly extending rib 56A which is located between barrel head 46 and reel flange 51 and serves to retain the cable 52 in the reel and avoid wedging of the cable between the reel and the housing. The reel housing 54, the bearing plate 15, and the supporting housing 10 are secured together by means of a plurality

of machine screws 56B passing through openings in the flange 55 and registering openings in the bearing plate 15 and through openings in the inwardly extending flange 14 of the supporting housing 10 and such machine screws 56B are threaded into a ring 57 which is held in position by means of down struck and laterally bent tongues 58 on flange 14 passing through apertures in the threaded ring 57.

The shaft 19 is provided with a shoulder 59 and a flattened portion 60 with a threaded end 61 upon which the spring barrel 46 and reel disc 50 are mounted by means of an elongated central aperture therethrough registering with the flattened portion 60 of the shaft. A washer 62 and a nut 63 provide means for retaining the barrel and reel disc in fixed position on the shaft and such structure also determines the clearance between the bearing flange 17 and the inwardly extending flange 25 of clutch member 24 so that the corrugated spring washer 26 will produce the proper drag on the outer clutch member 24. The shaft 19 is also provided with an oil hole 64 whereby the shaft may be lubricated through the central aperture 56 of the reel housing.

The cable 52 extends outwardly through a bell-shaped member 65 fixed to the appropriate side of the projecting lobe and upon the outer end of the cable a sleeve 66 is secured by means of crimps 67 for fixedly securing the sleeve to the cable. Upon the outer end of the sleeve a washer 68 is fixed by expansion of the sleeve 66 therearound as shown at 69. A handle 70 includes a shank 71 which is bored to receive the cable 53 and the sleeve 66 as well as the washer 68, the washer 68 being tightly received in an enlarged portion of the bore thereby fixing the handle on the cable. The inner end of the bore is enlarged and flared to prevent sharp bending of the cable.

In the event that the tension of spring 45 is insufficient to properly draw the cable around the reel, the screws 55 are removed and the reel housing is rotated in a clockwise direction as viewed from above relative to the bearing plate 15 and when sufficient tension has been provided, the reel housing 54 is positioned so that upstanding nobs 73 on the bearing plate extend into the coresponding holes in the flange 55 of reel housing 54 and the screws 56 are threaded into the ring 57 thereby maintaining the parts in assembled relation. The device may be mounted upon a motor by means of conventional attaching screws passing through holes 74 in the outwardly extending flange 11 of the supporting housing.

When the handle 70 is pulled outwardly the cable 52 unwinds causing the shaft 19 to rotate counter-clockwise as viewed from below, thereby causing rotation of inner clutch member 22, the outer clutch member tending to remain stationary, but the outer clutch member rotates as soon as the lost motion is taken up by the pins 31 coming in contact with the ends of the arcuate slots 28 and in such relative rotation the lugs 33 of the keys or dogs 32 cause the dogs to move to their inner positions thereby engaging the nut 13 and causing rotation thereof and thereby rotating the shaft to which such nut is attached.

Although the device has been shown to have a supporting housing or mounting 10 for attachment to a motor, such supporting housing or mounting 10 may be omitted and the device held in one hand with the opening 37 of the disc plate 36 embracing the nut on the shaft 12. The motor may be started by a pull on the cable 52 after which the starter can be removed and used for starting other motors.

Referring more particularly to Figs. 6 to 11, a reel housing includes a main body 75 having a substantially flat bottom with a bearing 76 projecting upwardly from the center thereof and having an upstanding peripheral wall 77 provided with a rabbet 78 completely around the periphery. A cover 79 having a downwardly extending peripheral wall 80 has its wall rabbeted at 81 for telescopically receiving the rabbeted portion 78 of the main

body 75, the cover being held in assembled relation by counter-sunk screws 82 threaded into the upstanding walls. The cover as well as the body are provided with projecting portions 83 and the upper portion 83 is provided with a bore 84 and a bell-shaped guide 85 is frictionally held therein for guiding the cable.

A clutch member 86 is mounted on a shaft 87 and carries the disk plate and flange 88 in a manner substantially the same as that shown in Figs. 1 to 5 inclusive and the inner clutch member and the clutch dogs (not shown) is similar so a detailed description is omitted.

Mounted on the lower surface of the body 75 is a retainer element 89 which includes a flange 90 secured to the bottom wall of the body by rivets 91 or the like and such retainer includes a generally cylindrical wall 92 and an inwardly extending flange 93. The wall 92 is provided with outwardly struck portions 94 extending substantially the height of the retainer and leaf springs 95 are resiliently held in each adjacent pair thereof. The proportion of the parts are such that the leaf springs 95 resiliently engage the outer periphery of the cylindrical portion of the clutch element 86 thereby providing a frictional drag thereon for accomplishing the same purpose as the warped washer 26 in the previously described modification.

The inner end of the cable 96 extends into a groove or slot 97 in a reel disk 98 and the washer 99 is pressed downwardly by the nut 100 on shaft 87 forcing the washer into contact with the cable end 96 and retaining the inner end of the cable. A spring barrel 101 houses the usual coil spring 102 which is held in one of its ends to the bearing 76 and has its other end attached to the peripheral wall of the barrel in a manner similar to that previously described.

In Fig. 10 another form of leaf spring retainer 103 is shown to include an attaching flange 104, an inwardly extending flange 105, outwardly struck portions 106 with leaf springs 95 held therein and such retainer may be secured to a bearing plate 107 by spot welding 108 thereby providing another manner of securing the leaf spring retainer in position on the housing and making the leaf spring retainer 103 adaptable for direct attachment to bearing plate 15 as a substitute for warped spring washer 26 shown in Figs. 1 to 5 without invloving any modification of the structure of the rest of the starting device.

With the modification in Figs. 6 to 11, it will be evident that the supporting housing is omitted and the starter is carried by the operator to the motor to be started and the disk plate is placed over the nut which secures the flywheel to the motor. The operator holds the housing body 75 and cover 79 in one hand to keep the clutch on the flywheel nut and then pulls on the cable 96 in the usual manner with the handle 70 causing the clutch dogs or lugs to engage the nut on the flywheel of the internal combustion engine, thereby starting the engine. It will be apparent that the housing body 75 and cover 79 may be used for either clockwise or counter-clockwise starting by merely drilling the bore 84 from one surface or the other of the projecting portion 83 and reversing the spring 102.

With the present invention the location of the clutch is not critical in an axial direction as long as the lugs engage the nut. The clutch is self-centering if it is slightly eccentric at the time it is applied and therefore the present invention reduces the difficulty of mounting fixed starters or of applying portable starters to present motors. Although the starters may be used with a conventional nut, frequently a large nut is desirable to make the starter more positive in its action and the motors may be supplied with a nut having the correct outside dimensions thereby making it unnecessary to have a large inventory of starters for different sizes of motors.

It will be obvious to those skilled in the art, that various changes may be made in the invention without

departing from the spirit and scope thereof, and therefore, the invention is not limited by that which is shown in the drawings and described in the specification, but only as indicated in the appended claims.

What is claimed is:

1. A portable starter for internal combustion engines comprising a housing closed at the top and open at the bottom and having a portion of generally circular outline with an outward extension thereon, a plate mounted on the open bottom of said housing, a bearing in said plate, a spiral spring having its inner end fixed in said bearing, a barrel open at the bottom and closed at the top retaining said spiral spring, the outer end of said spiral spring being connected to the periphery of said barrel, the plate preventing the spring from being unintentionally removed from said barrel, a shaft rotatably mounted in said bearing and having a shoulder above said bearing formed by a reduction in the diameter of the shaft and having a flat portion adjacent the shoulder, the barrel of said spiral spring having a corresponding elongated opening non-rotatably receiving said flattened portion of the shaft, a real plate having a central portion of generally circular outline on the outer surface of said barrel, said reel plate having a marginal portion offset from the central portion by approximately the diameter of a cable, said offset portion of the reel plate extending into the central portion in a smooth curve, an aperture in the central portion adjacent the smooth curve, a pin rotatable in said aperture, a cable having its inner end fixed to said pin and passing outwardly from the housing through an aperture in the elongated portion of the housing, a handle threaded on said cable, a sleeve fixedly secured to the outer end of said cable, a washer on said sleeve and fixed to the outer end thereof, said handle having a bore therethrough receiving said sleeve and tightly engaging said washer thereby fixing the outer end of the cable in said handle, said handle having a shank portion extending along said cable a distance appreciably greater than the length of said sleeve and preventing sharp bending of said cable, means mounted on said shaft on the lower side of said bearing plate for engaging peripheral projections on a shaft for driving the same.

2. A starter for internal combustion engines comprising a plate, a bearing in said plate, a shaft extending through said bearing and having a flange extending laterally from one end thereof, a first hollow cylinder having an inwardly extending flange in fixed engagement with said shaft flange and having an outwardly extending flange with a plurality of circumferentially extending arcuate slots and a corresponding number of cam shaped slots, a second hollow cylindrical member having an inwardly extending flange and an outwardly extending flange with said flanges and cylinders of said first and second cylinders being in nesting relation and the second member being rotatable relative to the first member, said second member having a plurality of outwardly extending lugs on the outwardly extending flange, a centrally apertured cover plate having a peripheral circumferential wall of a size to snugly receive the outwardly extending flange of said second member, said peripheral wall having notches therein for snugly receiving the projections on said flange of said second member, and a plurality of pins extending through the flange of said second member, the circumferential slots of said first member and through said cover plate, a plurality of keys between said cover plate and the outwardly extending flange of said first member and pivotally mounted on said pins, each of said keys having a lug projecting into the corresponding cam shaped slot in the outwardly extending flange of said first member to urge said keys inwardly, means on said keys for engaging a polygonal surface for applying torque to the polygonal member, spring means reacting between said second clutch member and said first-named plate for frictionally preventing said second member from rotating, and means on the shaft for rotating the shaft in both directions whereby the keys will be urged inwardly upon rotation in one direction to rotate the polygonal member and will be urged outwardly upon the rotation in the other direction.

3. Apparatus for producing rotation from linear movement comprising a spiral spring, a barrel surrounding said spiral spring, a shaft fixed to said barrel, a plate having a circular central portion in one plane and a peripheral portion in a plane spaced therefrom, said central portion being fixedly secured to the head of said barrel, the central portion of said plate having a spaced portion providing a smooth curve, said central portion adjacent the spaced portion being provided with an abutment, a short pin in said abutment within the confines of said central portion, a cable fixedly secured to said short pin for winding around said central portion in the space between the outer portion of said plate and the adjacent surface of said barrel, a crimped sleeve on the outer end of said cable, a washer on said sleeve, a handle mounted on said cable and surrounding said sleeve and tightly engaging said washer for retaining the end of the cable in fixed position on the handle, a portion of said handle extending inwardly from the inner end of said sleeve and preventing sharp bending of the cable.

4. Apparatus for producing rotation comprising a reel housing open at the bottom, a bearing plate removably secured to the housing and closing the same, a bearing mounted in said bearing plate and projecting into said housing, a shaft rotatably mounted in said bearing, a spiral spring in said housing and having its inner end secured to the outer portion of the bearing, a barrel surrounding said spring, the outer end of said spring being connected to the periphery of said barrel, the head of said barrel being non-rotatably connected to said shaft, a reel fixed on said shaft and said barrel, a cable, means to connect the inner end of the cable to said reel for smooth winding thereon without any appreciable tendency to project outwardly, said housing being provided with a cable passage to the exterior thereof, said cable passing through said passage and a handle secured to the outer end of said cable, means to prevent the shaft from becoming disengaged from said bearing, and means on the outer end of said shaft for connection to a rotatable member for causing rotation in one direction when said cable is unwound from said reel, said spring serving to rewind the cable on said reel.

5. A clutch mechanism for causing rotation in one direction comprising a shaft, a first clutch member having a cylindrical portion and an inwardly extending flange at one end thereof and an outwardly extending flange at the outer end thereof, said first clutch member being fixed to said shaft, a second clutch member nestingly receiving said first clutch member and including a cylindrical portion and an inwardly extending flange at one end and an outwardly extending flange at the other, said outer flange on said first member being provided with circumferentially extending arcuate slots and spirally arranged cam slots, pins extending through the outer flange of said first member and the circumferentially extending arcuate slots of the outer flange of the first member whereby the first and second members may have limited rotative movement with respect to one another, a dog pivotally mounted on each pin, each dog having a lug for engaging one of the cam slots, means on each dog for engaging a non-circular projection on an element to be rotated, said cam slots being arranged so that rotational movement of said shaft in one direction will cause said dogs to move towards said non-circular projection, for rotating the element.

6. A ratchet mechanism comprising a first member having a first flange and mounted for rotation and means for forcibly rotating said first member, a second member having a second flange loosely rotatable on said first member, means to frictionally resist rotation of said second member, cam slots on said first flange, a plurality

of keys pivotally mounted on said second flange and each having a lug engaging one of said cam slots, said keys being moved inwardly or outwardly in accordance with the direction of rotation of said first flange and the frictional retarding effect on said second member.

7. A ratchet mechanism for causing rotation of a regular polygonal prism comprising a housing, a first member rotatable in said housing, means to rotate said first member, a second member rotatably mounted in said housing relatively rotatable with respect to said first member, movable means mounted on said second member and actuated by said first member for movement toward and from the axis of rotation of said first and second members for causing rotation of said regular polygonal prism, said movable means having a shoulder and a guiding surface for contacting adjacent planes of the prism and having portions for engaging said adjacent planes of the prism whereby rotation of said prism at a faster rate than the rotation of said first member will cause release of said movable means from said prism.

8. A housing for a cable and drum structure comprising a relatively flat disc, a peripheral flange extending laterally from said disc and having an inwardly projecting rib, a reel rotatably mounted in said housing and having flanges arranged on opposite sides of said rib with said flanges spaced apart approximately the diameter of the cable used therewith, said housing having an opening for the passage of said cable substantially tangential to the drum and in approximately the plane of said inwardly extending rib whereby the cable will be retained within the flanges of said drum and prevented from entanglement thereof, said rib extending sufficiently close to said reel flanges to prevent the cable from passing between said reel flanges and said housing, said reel flanges being spaced apart a distance to accommodate only one spiral of the cable.

9. A portable structure for producing rotary motion from linear motion comprising a housing having a portion of generally circular outline with a projecting lobe from such portion, a drum rotatably mounted in said housing substantially concentric with said circular portion, a cable passing through the lobe of said housing and secured to the drum for projection tangentially of said drum, and means on the drum reacting between the drum and the housing for winding the cable of the drum, said drum being rotatable in the opposite direction by a linear pull on said cable, and means fixed to said drum for connection to a shaft for producing rotary motion of said shaft in one direction of movement caused by the linear pull on said cable, said connection means being immediately released when said shaft rotates at a higher speed than said drum whereby said portable structure may be removed from the shaft.

10. The invention according to claim 9 in which the drum and the securement of the cable to the drum comprises a substantially flat disk, a second disk arranged in spaced relation to said first disk approximately the thickness of the cable, said second disk having a portion offset substantially the thickness of the cable to provide for maintaining the spacing of said disks, said offset being provided with an aperture therethrough for pivotally receiving a cable anchoring pin, said aperture being of appreciably greater diameter than said cable, the inner end of said cable passing through a bore in said pin and secured to said pin substantially transverse to the axis of said pin, the aperture in said offset being located inwardly of the outer periphery of said offset whereby the cable may extend from said pin around the outer periphery of said offset to reduce the effect of the resiliency of the cable when wrapped around said offset whereby the cable may extend substantially tangentially of the outer periphery of the said offset thereby avoiding any appreciable tendency of the cable to unwind from the drum.

11. A portable starter comprising a body having an upstanding bearing therein and a peripheral wall thereround, a cover having a top wall and a peripheral wall telescopically receiving a portion of the wall of said body, and secured thereto, a reel positioned within said body; a shaft rotatably mounted in said bearing and fixedly connected to said reel, a spring for rotating said reel in one direction and a cable wound on said reel for rotating the reel in the other direction, a bell-shaped guide mounted on said cover and aligned with said reel for guiding the cable from the reel outside of said cover, a cylindrical clutch element mounted on said shaft, a spring retainer mounted on said body, a spring in said spring retainer reacting against the cylindrical portion of said clutch for providing a frictional resistance to turning, and means on said clutch for engaging a rotatable element for causing rotation of said rotatable element when the cable is unwound from said reel.

12. A clutch comprising a body, a bearing on said body, a shaft rotatably mounted in said bearing, a clutch element fixed on said shaft, means reacting between said body and said clutch element for providing a frictional drag on said clutch element, said reacting means including a retainer on said body with grooves on the inner periphery of said retainer, leaf springs mounted in said grooves and retained therein by the resiliency of said springs, means carried by said clutch element for engaging a rotatable member and causing rotation of said rotatable member in one direction only whereby said clutch may apply a turning torque to the rotatable member.

13. A portable starter comprising a body having a bearing therein, a cover for said body, said body and said cover providing a peripheral wall therearound, a reel positioned within said body, a shaft rotatably mounted in said bearing and fixedly connected to said reel, a spring for rotating said reel in one direction and a cable wound in said reel for rotating the reel in the other direction, a guide mounted on said cover and body and aligned with said reel for guiding the cable from the reel outside of said body and cover, a clutch element mounted on said shaft, a spring retainer mounted on said body, a spring in said spring retainer reacting against said clutch for providing a frictional resistance to turning, and means on said clutch for engaging a rotatable element for causing rotation of said rotatable element when the cable is unwound from said reel.

14. A ratchet mechanism for use on a regular symmetrical polygonal prism for applying a positive torque to such polygonal prism, said ratchet comprising a cam disk having a plurality of arcuate slots therein, and an equal number of spiral cam shaped slots extending from adjacent the periphery of the disk to adjacent the axis thereof, means to rotate said disk in a direction so that the trailing ends of the cam shaped slots are close to the axis while the leading ends of the cam shaped slots are distant from the axis, a pawl carrying disk rotatably mounted relatively to the cam disk, a plurality of elongated pawls corresponding to the arcuate slots pivotally mounted at their trailing ends on pins fixed to said pawl disk and extending through said arcuate slots, each pawl having a shoulder on its inner edge intermediate its ends adapted to abut a face of said polygonal prism, cam followers on said pawls engaging said spiral slots whereby when said cam disk is rotated in a direction so the outer portions of the spiral slots are leading, said spiral slots cause said pawls to move inwardly so the shoulders of said pawls will engage the faces of said polygonal prism for producing rotation thereof while reverse rotation of said cam disk relative to said pawl disk will release said pawls from said polygonal prism.

15. The invention according to claim 14 in which said cam surfaces are arranged to positively maintain said pawls in operative and inoperative positions and are releasable only when said cam disk is rotated reversely with respect to said pawl disk.

16. A ratchet mechanism for use on a regular polygonal prism for applying a positive torque to such polygonal prism, said ratchet comprising a first disk, means to rotate first disk in one direction to produce torque on said disk in said one direction, a second disk rotatably mounted with respect to said first disk, means to cause relative rotation between said first and second disks upon rotation of said first disk in said one direction, a pawl mounted on said second disk, cooperating cam means on said first disk and said pawl whereby rotation of said one disk in said one direction will cause said pawl to move toward said prism, and means on said pawl to engage a face of said prism when said first disk is rotated in said one direction, relative rotation of said first disk in the opposite direction with respect to said second disk releasing said pawl from said prism.

17. A ratchet mechanism for use on a regular polygonal prism for applying a positive torque to such polygonal prism, said ratchet comprising a disk, means to rotate said disk in one direction to produce torque on said disk in said one direction, a pawl mounted for movement on said disk, a pawl operating member rotatably mounted with respect to said first disk, means to cause relative rotation between said disk and said pawl operating member upon rotation of said disk in said one direction, cooperating toggle means formed by said disk, said pawl operating member, and said pawl whereby rotation of said one disk will cause said pawl to move toward said prism and be retained by said toggle means, and means on said pawl to engage a face of said prism when said disk is rotated in said one direction, relative rotation of said disk in the opposite direction with respect to said pawl operating member releasing said pawl from said prism.

18. The invention according to claim 17 in which the prism engaging means on the pawl is located between the mounting of the pawl on said disk and the connection to said pawl operating member.

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