April 2, 1935. J. W. ALLEN 1,996,733

STARTING MECHANISM

Filed June 22, 1932

Fig. 1

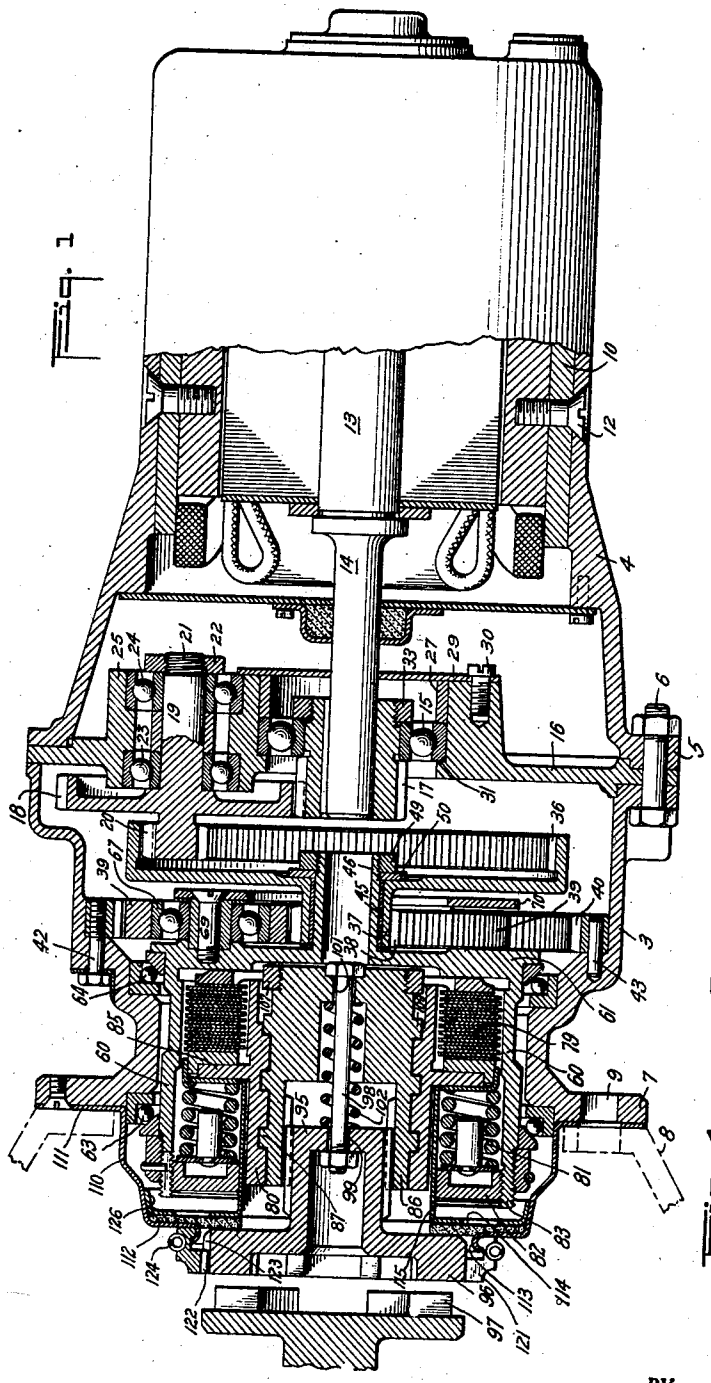


Fig. 2

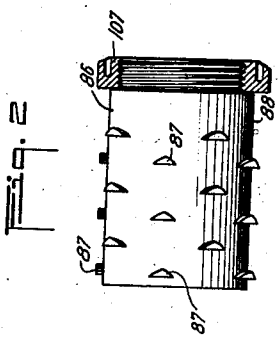


Fig. 3

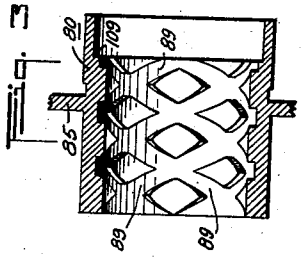
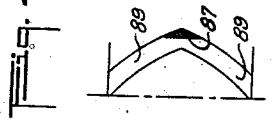


Fig. 4



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Patented Apr. 2, 1935 1,996,733

UNITED STATES PATENT OFFICE

1,996,733

STARTING MECHANISM

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Application June 22, 1932, Serial No. 618,792

9 Claims. (Cl. 74—7)

This invention relates to starting mechanism for internal combustion engines, and particularly to engine starters of the type in which starting is effected by transmission of torque to the engine crankshaft or its equivalent. The invention is further applicable to driving mechanisms of general application outside the engine starting art.

An object of the present invention is to provide novel means whereby driving torque may be transmitted to a member to be driven to cause rotation thereof in either direction as desired.

Another object of the invention is to provide an engine starting mechanism embodying a novel motion converting device associated with the engine-engaging means, whereby the engine may be turned over in either a clockwise or counter-clockwise direction as desired.

A further object is to provide novel means for supporting and actuating the novel motion converting device above referred to, whereby compactness and symmetry is achieved with an economy in both space consumed and number of parts employed. In this connection, a feature of the invention is the provision of an engine starter employing a pair of concentrically disposed, rotatable members each having projections so disposed as to interengage to cause a limited axial shifting of one member in response to initial rotation of the other, the direction of axial shift of the first named member being the same for either clockwise or counter-clockwise rotation of the second member.

These and other objects and advantages to be derived from the use of the invention herein disclosed will become apparent upon an inspection of the following specification, reference being had to the accompanying drawing, wherein the preferred embodiment of the invention is disclosed. It is to be understood, however, that the drawing is for the purpose of illustration only and is not designed as a definition of the limits of the invention, reference being had for such purpose to the appended claims.

In the drawing,

Fig. 1 is a longitudinal sectional view of a device embodying the invention;

Fig. 2 is a view in elevation of one of the two concentrically disposed motion converting members above described;

Fig. 3 is a longitudinal sectional view of the other motion converting member; and

Fig. 4 is a diagrammatic representation of the action of the parts shown in Figs. 2 and 3.

Referring to the drawing, and particularly to Fig. 1, the invention is shown embodied in a housing constituted by an inner section 3 and an outer section 4 having a suitable flange 5 to receive bolts 6 for detachably connecting said sections. The inner section 3 is provided with a flange 7 for engagement with a mounting flange 8 formed on the engine casing, the fastening means being insertable through a series of openings, one of which is indicated at 9. Secured within section 4 is an electric motor provided with a casing 10 having openings to receive screws 12 which may be employed for detachably securing the motor to the housing 4. While the construction herein disclosed is particularly well suited for application to a motor drive in the manner shown, it is to be understood that the invention embraces the use of other driving means, including hand operated means.

When a motor is employed, it may be of any suitable type including an armature shaft 13 provided with a laterally projecting reduced portion 14 that is rotatably mounted, as by means of a suitable bearing 15, in the dividing wall 16 interposed between casing sections 3 and 4. Drivably connected to the reduced portion 14 of the armature shaft is a pinion 17 meshing with a spur gear 18 which in the form shown is integral with a shaft 19 one end of which is cut to form a pinion 20 and the other end of which is threaded as indicated at 21 for reception of a retaining nut 22 adapted to hold it from axial displacement within the ball bearing assemblies 23 and 24, facilitating free rotation of the shaft 19 in the hub 25, the latter constituting a support not only for the bearings 23 and 24, but also for the bearing 15 previously described. The latter bearing is also provided with a suitable retaining sleeve 27 held in place by a plate 29 secured to the hub 25 by suitable means 30. The bearing assembly 15 also engages a shoulder 31 formed in the hub 25 and the bearing thus acts to absorb the thrust of the pinion 17 transmitted through the retaining nut 33 threadedly engaging the motor end of the pinion.

The pinion 20 is adapted to mesh with an internal gear 36 which has a hub 37 provided with teeth 38 so that it constitutes a sun gear for a plurality of planetary gears 39 which are rotatably mounted to mesh with an internal gear 40 fixedly secured to the housing by suitable bolts 42, the gear being initially located by a dowel pin 43 or its equivalent. The gear 36 and its hub 37 are rotatably mounted as by means of a bushing 45 on a stub shaft 46, the outer reduced end of which is threaded for engagement by a retaining nut 49, which in conjunction with the disc 50 and

bushing 45 restrain the gears from relative displacement.

A cylindrical member 60 preferably corresponding to what is termed in the art as a barrel, has a closed end 61 from which the shaft portion 46 projects, the barrel being rotatably mounted in ball bearing assemblies 63 and 64 received in suitable annular recesses formed in the wall of casing section 3. Each of the planetary gears 39, one of which is shown in section in Fig. 1, is centrally apertured for reception of a ball bearing assembly 67 carried by a sleeve which is received at its inner end by a counterbore in the plate portion 61 of the barrel. Extending through each sleeve and threaded into the barrel end 61 is a screw 69 adapted to support the corresponding sleeve, the bearing 67, and the planetary gear 39. Preferably a retaining ring 70 for the bearings 67 is provided, said ring being held in place by the heads of screws 69.

A multiple disc clutch is preferably provided in association with the barrel 60, to insure relative rotary movement between the engine engaging member and the train of gearing above described, whereby the latter is protected from damage due to an excessive shock or load. As shown, the disc clutch comprises a plurality of inter-leaving discs 79, alternately splined to the inner surface of the barrel 60, and the outer surface of a shell 80 constituting one of the two novel motion converting members referred to in the introductory portion of this description. Resilient means, such as a plurality of coiled compression springs 81, the pressure of which is adjustable by a nut 82 threadedly engaging the end 83 of the barrel, are provided to press upon a flange 85 on member 80, and thus maintain the discs 79 in frictional engagement with a pressure sufficient to insure transmission of torque from member 61, up to a predetermined capacity.

The second novel motion converting member which coacts with the member 80 to drivably connect the latter member with the engine crankshaft or other member to be driven to rotate the latter in either a clockwise or counter-clockwise direction as desired, is shown at 86 in Figs. 1 and 2. As indicated best in Fig. 2, the member 86 is substantially cylindrical in form, with its surface cut away along intersecting paths disposed obliquely to the axis of the member and spaced so as to leave remaining portions 87 in the nature of studs projecting from the major portion 88 of reduced diameter, and assuming a substantially triangular shape, although practically any other geometrical form can be substituted; moreover, these studs may, if preferred, be separate pieces attached to the surface of the cylinder 86 in any suitable manner. The inner surface of the cooperating cylindrical shell 80 is similarly cut along interesecting diagonal paths forming grooves 89 of a diameter such as to permit the projections 87 on the shaft 86 to register therewith in the manner indicated diagrammatically in Fig. 4. With the starter at rest in the normal position, as indicated in Fig. 1, the studs 87 lie in the intersections between successive grooves 89, occupying positions in relation to said grooves similar to the position indicated for the stud 87 in the diagram of Fig. 4. Moreover, the parts are designed of such relative dimensions that the length of each groove 89 from intersection to intersection is somewhat greater than the total possible axial travel of the member 88, for a purpose which will become apparent in the following description of what occurs as the parts begin to move.

From these illustrations it will be apparent that upon rotation of the driving member 80 in a clockwise direction, as viewed from the right of Fig. 3, a cam action will be produced between the registering obliquely disposed sides of the grooves 89 and the projections 87, the registering sides being those shown in Fig. 3 as sloping downwardly from left to right. As a result of such cam action, the projections 87 will be caused to slide along the grooves 89 in a direction toward the left, as viewed in Figs. 2 and 3, and such action will result in a leftward displacement of the shaft 86 relatively to the sleeve 80. On the other hand, if the sleeve 80 should rotate in a counter-clockwise direction, a similar cam action will be produced, but in such event, it will be the oppositely directed grooves 89 of the shell 80 which will receive, and direct the leftward movement of the projections 87; that is, those which, as viewed in Fig. 3, slope downwardly from right to left. Thus it is apparent that with either clockwise or counter-clockwise rotation of the shell 80, the reaction upon the projections 87 of the shaft 86 will move the latter to the left, assuming of course that the inertia, or latent opposition to rotation due to the mass of the member 86 and other factors, is greater than the resistance to axial movement of said member.

In order to assure that this condition will in fact exist, and in order to provide for the possibility of such axial movement of the shaft 86, the latter is splined to, but spaced axially from the end portion 95 (Fig. 1) of a clutch element 96, which, as shown, is normally out of engagement with a cooperating clutch element 97 associated with the engine or other member to be driven. A coupling pin 98 preferably passes through the central bores 99 and 101 in the members 96 and 86, respectively, and is surrounded by a compression spring 102 which bears yieldingly upon the lateral surfaces of the members 96 and 86 to constitute the means for yieldably imparting the thrust created by the leftward movement of the member 86 to the clutch element 96 and thus move the latter into engagement with the clutch element 97. A nut is threaded to the end of the shaft 86, as indicated at 107, and acts to limit the axial movement of the latter by coming into contact with the shoulder 109 (Figs. 1 and 3) formed on the internal surface of the shell 80 at the junction of the smooth portion thereof with the grooved portion.

As previously pointed out, this limit of axial movement is set so that the total possible axial movement of the member 88 is substantially less than the distance between successive intersections of the grooves 89. Therefore, the studs 87 will be incapable of traversing the full length of their respective grooves 89, the camming movement being halted and converted into a rotational movement at a point somewhat short of the succeeding intersection. By this means a positive and predetermined control of the cam action in both directions is assured.

Fitted over the inner end of the starter is a cup-shaped member 110 that is preferably formed of metal and is provided with a flange 111 adapted to be clamped between flange 7 of the starter housing and the engine flange 8. The inner portion of member 110 is bent inwardly toward jaw member 96 as at 112, and is provided with a central opening which is slightly larger in diameter than the outer diamter of the jaw

member 96. Preferably member 110 is strengthened adjacent said opening by being bent or curved, as at 113, the lip thus formed serving to receive a split ring 121 composed of a plurality of segments each of which has inwardly extending teeth or lugs 122 engageable with correspondingly spaced grooves 123 cut along the peripheral surface of clutch member 96. A toroidal spring 124 surrounds the split ring 121, resting in an annular groove formed in the periphery thereof. This spring 124 serves to yieldingly restrain the ring 121, and hence the clutch element 96, against immediate rotation in response to the initial rotary movement of the member 80, and thus cooperates with the members 80 and 86 in converting the initial rotary movement into an axial movement of the member 86, which axial movement is effective to move the clutch element 96 into mesh with the engine member 97.

In order to prevent seepage of oil through the central openings in member 110, the later preferably carries a washer 114 which may be formed of leather or equivalent material. Normally, the inner portion of washer 114 is held in engagement with the adjacent surface of the head of jaw member 96 by means of a flanged sleeve 115 which slidably surrounds the outer cylindrical surface of the member 80 and abuts at its end against the flange 85 provided on the part 80. If desired, a metal ring 126 may be provided to clamp the washer 114 to the cap member 110.

In operation, if the engine or other member to be driven is to be turned in a clockwise direction, the electrical connections (not shown) to the motor are appropriately set and the current is caused to flow through the windings thereof. The resulting rotation of the armature shaft 13 is transmitted through the reduction gearing illustrated, to the barrel 60, the latter rotating in the opposite direction with the particular gear arrangement shown, although this is of course subject to variations. On the other hand, a reversal of the motor connections will produce a corresponding reversal in the direction of rotation of barrel 60. In either clockwise or counter-clockwise rotation however, the cam action between the grooves 89 of the driving member 80 and the projections 87 of the shaft 86 will cause the latter to move to the left and impart a thrust to the spring 102 on the clutch element 96, which thrust will act to produce engagement between the members 96 and 97. Thereupon the member 86 being incapable of further axial movement due to either the complete meshing of the jaws of members 96 and 97 or to the contacting of the shoulder 109 by the nut 107, the members 80 and 86 will become, in effect, keyed to the nut for rotation as a unit and the torque thus transmitted will be effective to turn over the engine crankshaft through the intermediate connections 96 and 97. When the engine thus starts under its own power, the resulting excess in torque on the part of the driven shaft 86 will cause a reverse cam action between the projections 87 and the grooves 89 and as a result thereof, the shaft 86 will move in an axial direction back to the original position indicated in Fig. 1, the clutch element 96 being simultaneously returned through the action of the coupling pin 98.

While it is obvious from the foregoing that the embodiment herein disclosed possesses practical merit, it is to be understood that this embodiment is not exclusive of others which may incorporate the novel provisions herein disclosed and claimed, and which will be suggested to persons skilled in the art on an examination of the foregoing description and the accompanying drawing.

It is to be understood therefore that various changes may be made in the construction, arrangement and inter-relation of the parts entering into the invention without departing from the spirit thereof, the extent of the included variations being ascertainable by reference to the appended claims.

What is claimed is:

1. An engine starter drive including a rotatable barrel, a substantially cylindrical shell arranged within and concentrically of the barrel, a friction clutch operatively connecting the barrel and shell, a rotatable longitudinally movable clutch element mounted axially and centrally of the barrel and shell and adapted to engage and drive a member of the engine to be started, and means coacting with the shell and clutch element for always causing the latter to move longitudinally into engine engaging position in response to rotation of said barrel in either the clockwise or counter-clockwise direction, said last named means also constituting the torque transmitting connection between said shell and clutch element, and operative to rotate the latter as it arrives at the engine engaging position.

2. An engine starter drive including a housing, a substantially cylindrical shell arranged within and concentrically of the housing, a rotatable longitudinally movable clutch element mounted axially and centrally of the shell and adapted to engage and drive a member of the engine to be started, and means coacting with the shell and clutch element for always causing the latter to move longitudinally into engine engaging position in response to rotation of said shell in either the clockwise or counter-clockwise direction, said coacting means comprising a shaft engaging a cross-grooved surface on said shell, and a plurality of cam elements on said shaft movable along different portions of said cross-grooved surface according to the direction of rotation of said shell, and also rotatable with said shell subsequent to said longitudinal movement.

3. A drive including a rotatable shell, a rotatable longitudinally movable clutch element mounted axially and centrally of the shell and adapted to engage and drive a second clutch element, means coacting with the shell and first named clutch element for always causing the latter to move longitudinally in the same direction in response to rotation of said shell in either the clockwise or counter-clockwise direction, said coacting means comprising a shaft engaging a cross-grooved surface on said shell, and a plurality of studs on said shaft movable along different portions of said cross-grooved surface according to the direction of rotation of said shell, and constituting the torque transmitting connection between said shaft and clutch element.

4. An engine starter drive including a rotatable driving member, a substantially cylindrical shell, means operatively connecting the driving member and shell, a rotatable clutch element mounted axially and centrally of the shell and adapted to engage and drive a member of the engine to be started, and torque transmitting means coacting with the shell and clutch element for always causing the latter to move into engine engaging position in response to rotation of said driving member in either the clockwise or counter-clockwise direction.

5. An engine starter drive including a rotatable driving member, a substantially cylindrical shell arranged within and concentrically of the driving member, means operatively connecting the driving member and shell, a rotatable longitudinally movable clutch element mounted axially and centrally of the driving member and shell and adapted to engage and drive a member of the engine to be started, and means coacting with the shell and clutch element for always causing the latter to move longitudinally into engine engaging position in response to rotation of said driving member in either the clockwise or counter-clockwise direction, said coacting means comprising a cross-grooved surface on said shell, and a plurality of torque transmitting cam elements engageable with different portions of said cross-grooved surface according to the direction of rotation of the shell.

6. An engine starter drive including a rotatable driving member, a substantially cylindrical shell, means operatively connecting the shell and driving member, a rotatable longitudinally movable shaft mounted axially and centrally of the driving member and shell, means for always causing the shaft to move longitudinally into engine cranking position in response to rotation of said driving member in either the clockwise or counter-clockwise direction, said coacting means comprising a cross-grooved surface on said shell and a plurality of torque transmitting studs on said shaft engageable with different portions of said cross-grooved surface according to the direction of rotation of the shell, and a driving connection between said shaft and clutch element.

7. An engine starter drive including a rotatable barrel, a substantially cylindrical shell arranged within and concentrically of the barrel, a friction clutch operatively connecting the barrel and shell, a rotatable clutch element adapted to engage and drive a member of the engine to be started, and torque transmitting means coacting with the shell and clutch element for always causing the latter to move into engine-engaging position in response to rotation of said barrel in either the clockwise or counter-clockwise direction.

8. An engine starter drive including a rotatable shaft, a driving member for said shaft, a clutch element splined to said shaft and adapted to engage and drive a member of the engine to be started, and means for always causing the clutch element to move into engine engaging position in response to rotation of said driving member in either the clockwise or counter-clockwise direction, said means comprising a shell having a cross-grooved surface and a plurality of torque transmitting studs on said shaft engageable with different portions of said cross-grooved surface according to the direction of rotation of said shell.

9. In a device of the class described, a rotatable driving member, a rotatable shaft arranged within and concentrically of the driving member, means including a rotatable shell operatively connecting the driving member and shaft, a rotatable clutch element mounted axially and centrally of the shaft and adapted to engage and drive a second clutch element, and means on said shell engageable with the shaft for always causing the clutch element to move into engaging position in response to rotation of said driving member in either the clockwise or counter-clockwise direction.

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