Dec. 5, 1933. H. C. EDWARDS 1,938,285

INTERNAL COMBUSTION ENGINE

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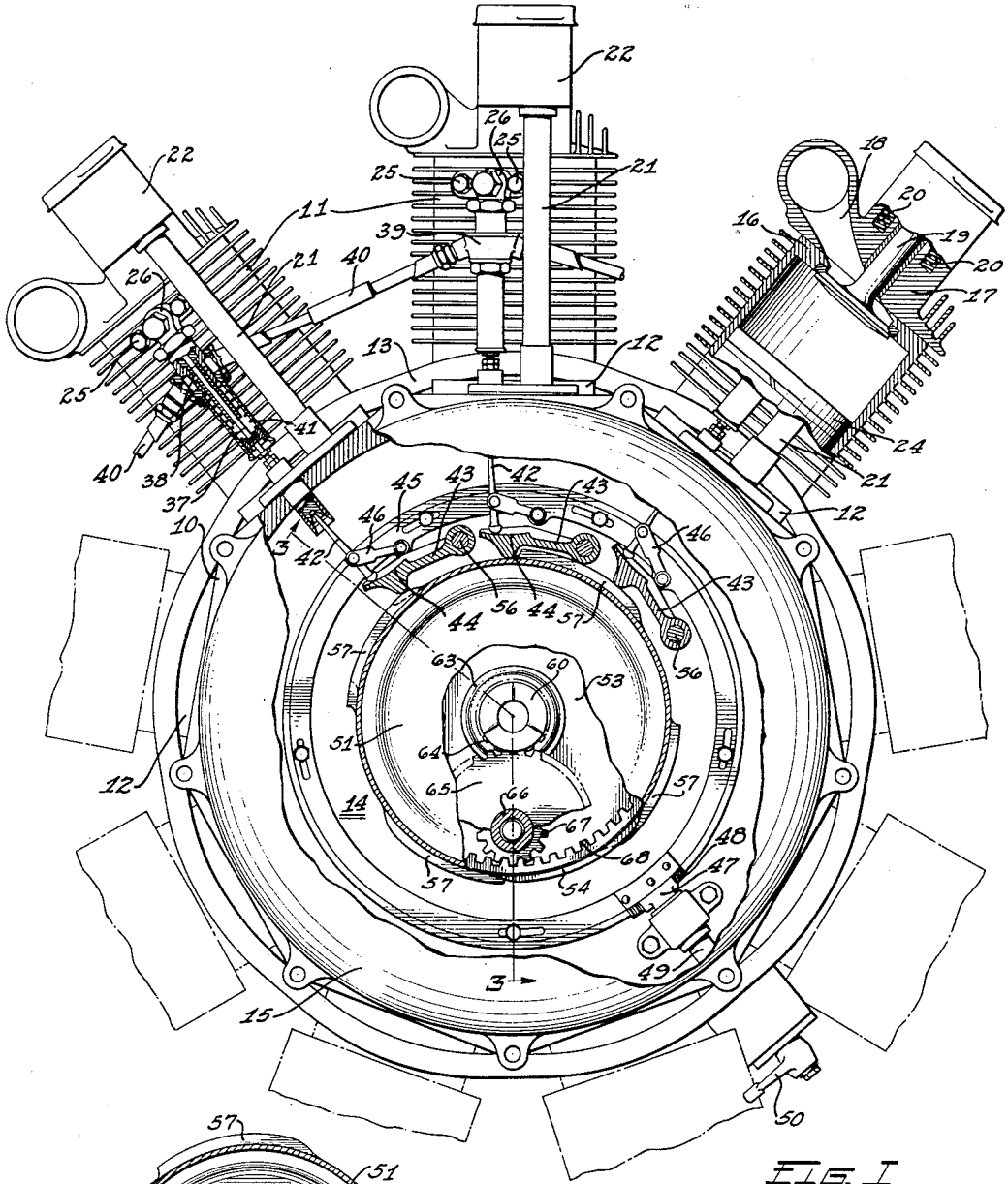


FIG. 1

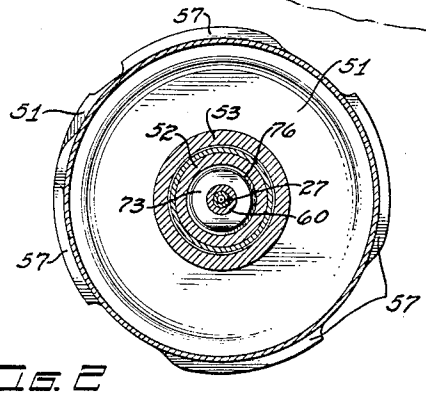


FIG. 2

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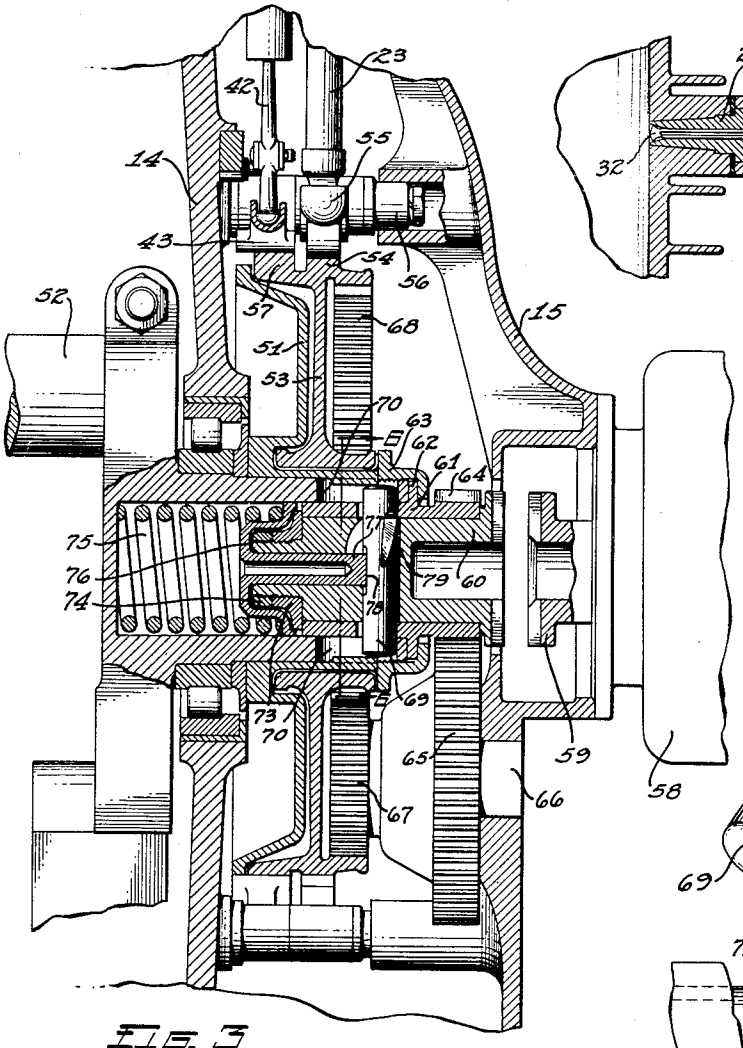


FIG. 3

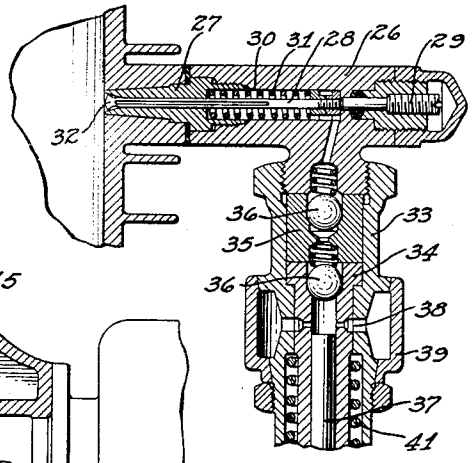


FIG. 4

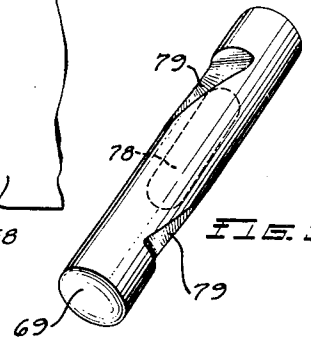


FIG. 5

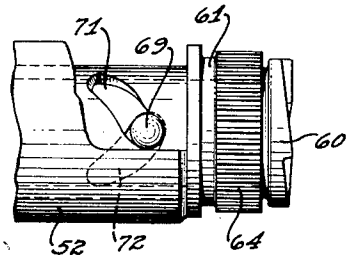


FIG. 7

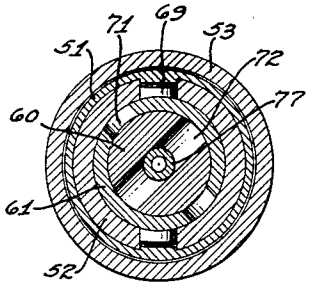


FIG. 6

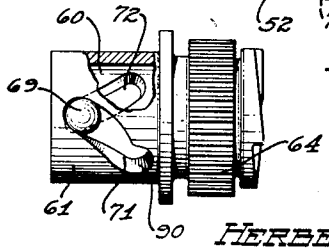


FIG. 8

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INTERNAL COMBUSTION ENGINE

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Application November 25, 1930
Serial No. 498,082

10 Claims. (Cl. 123—179)

This invention relates to internal combustion engines and more particularly to driving mechanism for fuel injection devices.

In engines of the fuel injection and Diesel type it has been found advantageous to provide two mechanisms operated at different speeds and driven from the crank shaft for actuating the pressure producing means for the fuel injection devices. It is desirable to provide mechanism driven at two speeds for operating such devices because mechanism driven from the crank shaft at a desired speed for efficient running operation does not create a pressure upon the fuel to cause sufficient penetration when the engine is idling or starting to result in a mixture with compressed air which will readily ignite through compression. The faster driven mechanism is made effective during starting and idling and will cause the proper force to be developed behind the oil injections to result in a penetration of the compressed air necessary to the formation of a mixture which will ignite readily from compression.

When such two-speed mechanism is controlled through the application of a starter and the relative movement of associated elements, there is ordinarily considerable friction developed which causes an undesirable wear of some of the parts, and it is an object of this invention to provide a driving and shifting mechanism for a fuel injection device cam of the type shown in application Serial No. 441,811 filed April 5, 1930, by Lionel M. Woolson in which the wear due to friction is eliminated.

Another object of the invention is to provide an internal combustion engine cam operating mechanism in which the relatively movable driving elements are provided with large bearing surfaces and are associated to substantially eliminate wearing due to friction and misplacement.

A further object of my invention is to provide an internal combustion engine in which a two-speed cam operating mechanism is driven and shifted axially through a driving mechanism including a pin which is formed with flat bearing surfaces for engagement with associated elements to prevent its displacement and wear due to friction.

These and other objects of the invention will appear from the following description taken in connection with the drawings, which form a part of this specification, and in which:

Fig. 1 is an end elevational view of a radial internal combustion engine having parts broken away and in section to show one of the fuel injection devices and the actuating mechanism therefor;

Fig. 2 is a view taken on lines 2—2 of Fig. 3 illustrating the relative position of the cams for actuating the fuel injection devices related so that the faster cam is effective;

Fig. 3 is a fragmentary sectional view of the engine taken on line 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view of one of the fuel injection devices and its associated cylinder;

Fig. 5 is a perspective view of the driving pin for the cam rotating and shifting mechanism;

Fig. 6 is a sectional view taken on line 6—6 of Fig. 3;

Fig. 7 is a fragmentary elevational view of the crank shaft extension and the associated driving sleeve connected by a pin in a relation such that the slower cam is in effective position for actuating the fuel devices;

Fig. 8 is another view of the crank shaft extension and the associated driving sleeve with the driving pin in position to cause the faster cam for actuating the fuel devices to be effective.

Referring now to the drawings by characters of reference, 10 indicates generally a barrel-like crank case of a radial internal combustion engine from which a plurality of cylinders 11 project. The cylinders are formed with flanges 12 which bear against the outer wall of the crank case and a pair of hoops, one of which is indicated at 13, encircle the flanges and hold them against the cylinder under compression. The crank case is formed with interior reinforcing walls, one of which is indicated at 14, and a rear end wall 15, while the crank shaft extends through the reinforcing walls and an axial opening in the rear end wall. The engine illustrated is preferably for use as the power plant of an aeroplane and a crank shaft at its forward end is associated with a propeller (not shown) in a conventional manner.

The cylinders are formed with an integral head 16 upon each of which is mounted an auxiliary head 17 and a Venturi passage 18 extends through each of the associated integral and auxiliary heads and provides for the inflow of air and the outflow of exhaust, such passages being arranged at an angle to the axis of the associated cylinder and tangentially to the inner wall thereof so that air drawn into the cylinder will be given a rotating movement. Each of the passages is controlled at its inner end by a valve 19 and a plurality of springs 20 normally maintain each of the valves in closed position. Suitable engine driven mechanism extending from within the crank shaft through the crank case and the housings 21 and 22 and each including a push rod 23 are arranged to cause opening movement of the valves 19. The engine illustrated is of the four-cycle type and the valve is held open by the engine driven mechanism during the exhaust and the air intake strokes of the pistons 24. It will

be understood that the pistons are connected with the crank shaft through a connecting rod assembly of the type which is conventional with radial engines.

With each of the cylinders there is associated an individual fuel oil injection device, each of which consists of a unitary nozzle and pump section, the nozzle section being secured directly to the cylinder by bolts 25. The nozzle section includes a casing 26 having an end 27 extending through an aperture in the wall of the cylinder, a valve 28 and a stop member 29. A chamber 30 extends axially of the nozzle and a spring 31 normally maintains the valve against the stop member so that the valve head 32 all but closes the conical passage at the inner end of the casing section 27. The pump casing 33 is screwed upon a neck depending from the nozzle casing and a barrel 34 is secured within the pump casing by a spacer 35 which is clamped against the upper flanged end of the barrel when the pump casing is screwed upon the pump section of the nozzle casing. A passage extends through the spacer of the neck portion of the nozzle casing and provides for communication between the chamber 30 and the interior of the pump barrel, such passage being closed by one-way valves 36 to prevent the return of oil from the nozzle to the pump. A plunger 37 is arranged to reciprocate within the barrel and during its movement covers or uncovers ports 38 which extend radially through the pump casing and the barrel. A housing 39 surrounds the exterior of the pump casing adjacent the ports and is secured in leak-proof relation and such housings are connected by conduits 40 so that an oil feeding manifold is thereby formed. A suitable source of supply and low pressure pump (not shown) are connected with such manifold.

Mechanism is provided for reciprocating each of the plungers 37 and consists of a spring 21 arranged between the barrel and the casing to normally move the plunger into retracted position and an articulated push rod structure 42 and a rock lever 43. The rock levers are formed with a curved face 44 against which the inner end of the articulated push rod structure bears and is adjustable lengthwise thereof, there being a ring 45, connected with the push rod structures by links 46, which can be rotated to move the push rod longitudinally upon the curved surfaces 44 of the rock levers 43. The ring is rotated through means of a gear sector 47 meshing with a rack 48 thereon, the gear sector being carried by a shaft 49 which can be rotated by a lever 50 through any suitable linkage. When the push rod structures are positioned near the free end of the rock levers, there will be the largest fuel injection obtainable because under such circumstances the plungers will move the greatest distance beyond the ports 38, it being understood that the stroke of the plungers after closing the ports determine the quantity of fuel which is moved through the nozzle into the compressed air in the cylinder. When the ring is turned to move the push rod structures toward the central portion of the rock levers the volume of the fuel charges will be proportionately reduced and the push rods can be moved in this direction to a point where the resulting movement imparted to the plungers will not cause them to close the ports 38 and under such circumstances there will be no oil delivery to the cylinders and the engine will not operate.

A single lobe cam 51 is keyed to the rear end of the crank shaft 52 and has a rearwardly extending hub upon which a duel cam 53 is rotatably mounted. This dual cam is provided with one set of lobes 54 for actuating slippers 55 with which the push rods 23 of the valve actuating mechanism are associated. The slippers 55 and the rock levers 43 are mounted side by side upon shafts 56 extending between the reinforcing wall 14 and the rear cover 15. The duel cam is also provided with a series of lobes 57 which are arranged in a plane to actuate the rock levers 43. The rock levers 43 are of such width that they will also be actuated by the single lobe cam in its rotation.

For normal running operation of the engine the cam 53 which is driven at one-eighth the crank shaft speed is effective, and the movement imparted to the pump plungers through the rock levers 43 and the push rod structures 42 is fast enough to inject the oil through the nozzles under a pressure which will cause the desired atomization and penetration of the air charges so that the commingling with the air under such circumstances will produce a mixture which will readily ignite under the heat of compression. However, when the engine is being started the cam 53 will be rotated so slowly that the resulting movement of the plungers will not exert sufficient pressure against the oil to produce the penetration thereby of the air charges which is necessary to the commingling required for combustion resulting from completion of the compression stroke of the pistons, and consequently I have provided the cam 51, which is rotated at crank shaft speed, to be effective during starting, and it will be seen that this cam, moving eight times faster than the cam 53, will create a much higher pressure behind the oil injections due to the faster movement of the pump plungers. This cam 51, when effective during starting, will create an oil pressure sufficient to penetrate well into the air charges in the cylinders so that the proper commingling occurs to result in combustion with very little turning of the crank shaft.

In order to control the relation of the two cams with the rock levers 43 so that only one is effective at a time, I provide a shiftable driving means between the crank shaft and the dual cam which is automatically actuated through the association therewith of the starter indicated generally at 58, the jaw portion 59 of which is movable axially and is rotated in a direction to turn the crank shaft.

The end of the crank shaft is hollow and an extension 60 is arranged to telescope partially therein, the end of such shaft extension being provided with jaws which are engaged by the jaw of the starter. A sleeve 61 telescopes the shaft extension and is substantially of the same diameter as the bore in the rear end of the main section of the crank shaft, and a flange 62 extends from the sleeve and is held against axial displacement by the nut 63 screwed on the shaft end. The nut also serves to prevent axial displacement of the cams 51 and 53. The shaft extension is provided with a gear 64 which meshes with a gear 65 carried by a shaft 66, and arranged upon this shaft is another gear 67 which meshes with the gear 68 forward interiorly of the rear end of the dual cam. This train of gears drives the dual cam from the crank shaft in a reverse direction to the rotation thereof and at one-eighth its speed.

In order that rotation may be imparted to the main section of the crank shaft by the starter

through the mechanism described, I provide a pin 69, the ends of which project into axially extending slots 70 formed in the main section of the crank shaft. The crank shaft extension is formed with a pair of oppositely disposed slots 71 which extend helically relative to the axis thereof, while the sleeve is formed with oppositely disposed slots 72 which extend helically relative to the axis thereof but in the opposite direction from the slots 71, and through such slots the driving pin 69 extends. The sleeve is secured axially upon the shaft extension by the bearing member 73 and the nut 74 which is screwed upon the front end of the shaft extension.

The pin is normally maintained in the rear end of the slots 71, 72 and 70 through means of the coil spring 75 which bears against the cap 76 which extends across the bore in the main section of the crank shaft and is provided with a relatively small stem 77 which passes through the front end of the crank shaft extension and engages in a recess 78 formed in the driving pin.

When the pin is in its rearmost position, as shown in Figs. 3 and 7, the lobes 57 on the dual cam will be in an effective position to actuate the rock levers 43, as shown in Fig. 2, because the dual cam through the driving gear train is arranged with respect to the crank shaft so that the lobes 57 will raise the free end of the rock levers prior to the time that the lobe on the single cam does and such cam lobes 57 are of a length such that they will hold the rock levers raised while the lobe on the cam 51 passes thereunder. When the starter is applied to the crank shaft extension, the initial rotation thereof will rotate the extension and will cause the driving pin 69 to move forwardly in the slots 70 of the main section of the crank shaft without rotating the same until the pin has reached the front end of the slot 71 at which time the main section of the crank shaft will be driven with the crank shaft extension. During the time the crank shaft extension is rotating without effecting rotation of the main crank shaft, the sleeve 61 will be rotating through axial movement of the pin to the same degree but in an opposite direction, and this rotation of the sleeve will rotate the gearing extending to the dual cam thereby causing the cam to be placed in a position such that the lobes 57 will be effective only after the lobes on the cam 51 have raised the free end of the rock levers 43. When the driving pin 69 is in the position shown in Fig. 3, the single lobe cam will be effective and will mask the lobes 57 so that they will pass under the rock levers without actuating the same. It will be seen that the time when the fuel charges are delivered is delayed when the single cam is effective, and this is of assistance in raising the temperature in the cylinders prior to the time of the fuel injection which aids in the fuel combustion when starting an engine of this type. When the engine starts to operate under its own power, the crank shaft will overrun the starter jaw and upon such release of the starter jaw, the spring 75 through the medium of the cap and the stem 77 will move the driving pin rearwardly and return the dual cam to effective running position through the rotation of the sleeve 61 and the train of gears extending therefrom to the dual cam. The arrangement of the cap 76 and the relatively small diameter stem 77 permits the crank shaft extension adjacent thereto to be formed relatively large in diameter, thus insuring ruggedness at this point.

The driving pin 69 is formed with two oppositely disposed flat faces 79 which start at the circumference near the middle of the pin and extend helically toward the ends, such surfaces extending gradually inwardly toward the pin axis as they approach the ends. These flat surfaces are of such length as to provide bearing surfaces with the helical walls in the extension formed by the slots 72, and through the provision of the pin bearing faces I have eliminated the pin wear, which would take place if the pin were round, due to its movement between starting and running positions. In order to maintain the pin so that it will not revolve and thus keep the faces in proper relation with the walls of the slots 72, I provide the stem 77 which engages in the pin recess 78. When in its most forward position the pin seats in the end of the slots 72, and not in the slots 71 so that the sleeve 52 will not be bound in any manner in its return to running position. When the pin is in its rear position it seats in offset pockets 99 forming the end of the slots 71 which effects a driving connection from the crank shaft to the sleeve 52 which will remain fixed during running operation of the engine. With this form of pin and slots, the mechanism will be retained in desired related positions during starting and running of the engine, and the shifting of the mechanism will cause no binding or wear of the relatively movable driving elements.

While I have herein described in some detail a specific embodiment of my invention, which I deem to be new and advantageous and may specifically claim, I do not desire it to be understood that my invention is limited to the exact details of the construction, as it will be apparent that changes may be made therein without departing from the spirit or scope of my invention.

What I claim is:

1. In a mechanism of the class described, a shaft having a hollow end with diametric axially extending slots through the wall, a gear carrying sleeve extending into the hollow end of the shaft and having diametrically disposed slots through the wall thereof extending at an angle to the axis, a starter jaw having a shaft portion extending through the sleeve and formed with diametic slots therethrough each having a substantially straight side and extending at an angle to the axis and in an opposite direction to the slots in the sleeve, a pin extending through the slots in the starter jaw shaft, the slots in the sleeve and into the slots in the shaft, said pin having a pair of flat surfaces engaging the straight sides of the walls formed by the slots in the starter jaw shaft, and means carried in the hollow end of the shaft engaging the pin to prevent rotation thereof.

2. In a mechanism of the class described, a shaft having a hollow end with oppositely disposed slots therein extending in an axial direction, a gear carrying sleeve extending into the hollow portion of the shaft and having oppositely disposed helically extending slots in the wall thereof, a starter jaw shaft extending through the sleeve and having a pair of opposite helical slots therein extending in an opposite direction to the slots in the sleeve, a pin extending through the slots in the starter jaw shaft and the slots in the sleeve and into the slots in the shaft, said pin having flat surfaces engaging one of the walls forming the slots in the sleeve, and means carried in the hollow end of the shaft engaging the pin to prevent rotation thereof.

3. In a mechanism of the class described, a

shaft having a hollow end with oppositely disposed slots therein extending in an axial direction, a gear carrying sleeve extending into the hollow end of the shaft and having oppositely disposed helically extending slots through the wall thereof, a starter jaw shaft projecting through the sleeve and having oppositely disposed helical slots therein extending in an opposite direction to the slots in the sleeve, a pin extending through the slots in the starter jaw shaft, the slots in the sleeve and into the slots in the shaft, said pin having helically extending flat surfaces formed on opposite sides thereof and engaging the wall of the starter jaw shaft forming the slots therein, and means carried in the hollow end of the shaft and engaging said pin to prevent rotation thereof.

4. In a mechanism of the class described, a shaft having a hollow end with oppositely disposed slots therethrough extending in an axial direction, a gear carrying sleeve telescoping into the hollow portion of the shaft and having oppositely disposed helical slots therein, a starter jaw shaft extending through the sleeve and having oppositely disposed helical slots therein arranged to extend in a direction opposite to that of the slots in the sleeve, a pin extending through the slots in the starter jaw shaft, the slots in the sleeve and into the slots in the shaft, said pin being formed with helically extending flat surfaces arranged to engage one of the wall portions forming the slots in the starter jaw shaft and beginning centrally from the circumference of the pin and angling inwardly toward the ends of the pin, and means movable in the hollow end of the shaft and engaging said pin to prevent rotation thereof.

5. In a mechanism of the class described, a shaft having a hollow end with oppositely disposed slots therein extending in an axial direction, a gear carrying sleeve telescoping into the hollow end of the shaft and having oppositely disposed helical slots therein, a starter jaw shaft extending through the sleeve and having oppositely disposed helical slots therein arranged to extend in an opposite direction to that in which the slots in the sleeve extend, a pin extending through the slots in the starter jaw shaft, the slots in the sleeve and into the slots in the shaft, said pin having flat surfaces engaging the wall forming one side of the slots in the starter jaw shaft, and means for retaining the pin in a fixed relation with the starter jaw shaft.

6. In a mechanism of the class described, a shaft having a hollow end with oppositely disposed slots therein extending in an axial direction, a gear carrying sleeve telescoping into the hollow end of the shaft and having oppositely disposed helical slots therein, a starter jaw shaft extending through the sleeve and having oppositely disposed helical slots therein arranged to extend in an opposite direction to that in which the slots in the sleeve extend, a pin extending through the slots in the starter jaw shaft, the slots in the sleeve and into the slots in the shaft, said pin having flat surfaces engaging the wall forming one side of the slots in the starter jaw shaft, and spring pressed means for retaining the pin in a definite relation with the starter jaw shaft.

7. In a mechanism of the class described, a shaft having a hollow end formed with oppositely disposed slots therein extending in an axial direction, a sleeve telescoping into the hollow end of the shaft and having oppositely disposed helical slots therein, a starter jaw shaft projecting through the sleeve and having oppositely disposed helical slots therein extending in a direction opposite to that in which the slots in the sleeve extend, a pin extending through the slots in the starter jaw shaft and in the sleeve and into the slots in the shaft, said pin having surfaces engaging a wall portion forming the slots in the starter jaw shaft, a cap member in the hollow portion of the shaft, a stem connected with the cap and extending through the front of the starter jaw shaft and engaging the pin to prevent rotation thereof, and a spring in the hollow portion of the shaft exerting pressure against the cap and stem in a direction toward the pin.

8. In a mechanism of the class described, a shaft having a hollow end formed with oppositely disposed slots therein extending in an axial direction, a sleeve telescoping into the hollow end of the shaft and having oppositely disposed helical slots therein, a starter jaw shaft projecting through the sleeve and having oppositely disposed helical slots therein extending in a direction opposite to that in which the slots in the sleeve extend, a pin extending through the slots in the starter jaw and the sleeve and projecting into the slots in the shaft, means normally urging the pin into a position at the rear end of the slots, the front end of the slots in said starter jaw shaft being behind the front end of the slots in the sleeve to prevent the pin from binding with the sleeve in its forward position, and means engaging the pin to prevent rotation thereof.

9. In a mechanism of the class described, a shaft having a hollow end formed with oppositely disposed slots through the wall thereof extending in an axial direction, a gear carrying sleeve telescoping into the hollow end of the shaft and having oppositely disposed helical slots therein, a starter jaw shaft extending through the sleeve and having oppositely disposed helical slots therein extending in an opposite direction to the slots in the sleeve, a pin extending through the slots in the starter jaw shaft and the sleeve and projecting into the slots in the shaft, said pin having flat surfaces engaging a wall portion forming the slots in the starter jaw shaft, means normally urging the pin into a position at the rear end of the slots, the rear end of the slots in the sleeve being in advance of the rear end of the slots in the starter jaw shaft and terminating in an offset pocket in which the pin has a driving relation when in its rearmost position.

10. In a mechanism of the class described, a shaft having a hollow end formed with diametrically axially extending slots through the wall, a gear carrying sleeve extending into the hollow shaft and having oppositely disposed helical slots therein, a starter jaw shaft extending through the sleeve and having oppositely disposed helical slots therein extending in an opposite direction to the slots in the sleeve, a pin extending through the slots in the starter jaw shaft and the sleeve and into the slots in the shaft, said pin having flat surfaces engaging a wall portion of the starter jaw shaft forming one side of the slots, and means normally urging the pin into a position at the rear end of the slots, the front end of the slots in the starter jaw shaft being behind the front end of the slots in the sleeve to prevent the pin from binding with the sleeve when in its forward position.

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