The present invention relates to engine starters and particularly to starter jaw advancing mechanism.

In engine starters it is desirable to have some method of automatically advancing the starter jaw into mesh with the engine jaw. One method which has been used comprises a nut, driven by a clutch and reduction gearing, which engages a screw shaft drivenly connected to the starter jaw. A rotational restraint is required to hold the jaw to cause the screw shaft to advance the nut thereby to move the starter jaw axially to the engaged position. One method of providing rotational restraint is a friction ring. The friction ring results in a loss of efficiency and a decrease of effectiveness of the jaw advance mechanism as the friction reduces due to wear in service. Another disadvantage is that the nut and screw shaft are located after the reduction gearing which requires that they be large enough to have sufficient strength for handling the high torque required for starting. The purpose of the screw shaft is to advance the jaw which requires a relatively small force. Hence, it could be a smaller mechanism if located in a more favorable position.

In copending application Serial No. 223,305, filed April 27, 1951, by Henry Troeger, the starter jaw is meshed by a cam action ahead of the reduction gearing. High starting torques cannot be applied until the jaw teeth are fully meshed. Also, the advancement of the starter jaw is rapid, thus preventing high impact loads due to high armature speeds as are obtained in other methods. It has been found, however, that to insure the advancement of the starter jaw into mesh with the engine jaw some means of rotational restraint is necessary.

In the present invention, rotational restraint is provided for the reduction gearing. Inasmuch as the restraint is in the low torque portion of the gearing, less restraint is required than if located on the starter jaw where the output torque is high.

An object of the present invention is to provide an improved starter.

Another object of the invention is to provide improved jaw meshing mechanism.

Another object of the invention is to provide novel positive jaw actuating mechanism.

Another object is to provide a jaw-advancing mechanism in which fewer, smaller and simpler parts are required.

Another object of the invention is to provide novel rotational restraining means.

Another object of the invention is to provide a relatively low cost engine starter.

The above and other objects and features of the invention will appear more fully hereinafter from a consideration of the following description taken in connection with the accompanying drawings wherein one embodiment of the invention is illustrated by way of example.

In the drawing:

Figure 1 is a partial sectional view of an engine starter embodying one form of the invention.

Figure 2 is an enlarged view of the restraining means of Figure 1.

Referring to the drawing, the device therein shown comprises a starter assembly including, in general, a motor 1 having a driving shaft 2 rotatably supported by a bearing 3 mounted in end wall 4 of motor housing 5. The shaft 2 has a counterbore portion 6 adapted to receive an enlarged portion 7 of a shaft 8. A helical cam 9 is formed in the enlarged portion 7 of the shaft 8. A pin 10 secured to the driving shaft 2 extends into the helical cam 9.

The shaft 8 has a pinion gear 11 integral therewith. The gear 11 meshes with planetary gear 12. The gear 12 is carried by a shaft 13 mounted in planetary case 14. The shaft 13 is secured in the case 14 by a pin 15 or in any other suitable manner. A wall 16 of gear housing 11 has a circumferential flange 18 for positioning the case 14. A bearing member 19 may be positioned between the case 14 and the flange 18. The gear 12 is adapted to mesh with a ring gear 20 secured against rotation to the housing 17 in any suitable manner.

Integral with the gear 12 is a gear 21 adapted to mesh with splines 22 of barrel 23. The barrel 23 is rotatably mounted in the housing 17. The inner surface of the housing 17 and outer surface of the barrel 23 are finished to provide bearing surfaces. It is understood, however, that the barrel 23 could be mounted in the housing 17 by other bearing means.

The barrel 23 is connected to starter jaw 24 by a clutch pack 25. The clutch pack 25 has one set of discs 26 splined to the barrel 23 and another set of discs 27 slidably splined to the jaw 24. Pressure is applied to the clutch pack 25 by means of a spring 28 which may be a belleville washer. A backing plate 29 is secured in position by a snap ring 30 placed in a groove 31 in the barrel 23.

A bearing support 32 is held against a shoulder 33 in the barrel 23 by the reaction of the
spring 28. The bearing support 32 has a cylindrical portion 34 extending into a counterebore portion 35 of jaw 24. A bearing 36 is piloted by and is free to move axially in the cylindrical portion 34. A shank portion of shaft 8 is secured to the bearing 35 by a shoulder 37 on the shaft 8 and a lock ring 38.

A mesh rod 39 extends axially of the counterebore portion 35 and extends through the jaw 24. A nut 40 retains the jaw 24 in operative relation with the mesh rod 39. The other end of the rod 39 terminates in a flanged portion 41 which pilots in the cylindrical portion 34. A spring 42 positioned between the flange 41 and the jaw 24 urges the jaw 24 into engagement with an engine jaw (not shown) upon being compressed by movement of the mesh rod 39. A spring 43 positioned between the flange 41 and a radially extending flange 44 on the cylindrical portion 35 serves to return the jaw 24 to a retracted position.

The housings 5 and 17 are secured together by bolts 45. The housing 17 has an outward extending flange 46 adapted to be secured to an engine housing 47 in a conventional manner, for example, by studs 48. An end cover 49 is secured to the housing 17 by the bolts 45.

The aforementioned arrangement is described and claimed in copending application Serial No. 223,305.

The present invention provides novel means for restraining rotation of the starter jaw 24 until it has been compressed into mesh by the action of the pin 10 in the slot 8. A spring washer 50 is positioned on the shaft 13 between a brass washer 51 and a head 52 of the shaft 13. A steel washer 53 is positioned between the washer 51 and the gear 12. Corresponding brass and steel washers 54 and 55 are positioned on the shaft 13 between the gear 21 and the pin 15.

In operation, upon the motor being energized, the acceleration of the armature shaft 2 will cause a torque to be applied to the shaft 8 through the pin 10. The spring washer 50 exerts a force against the washers 51, 53, gears 12-21, and washers 54 and 55 to restrain the gears 12-21 from rotation thereby causing the pin 10 to exert an axial thrust on the cam surface 8. This axial thrust due to the lead of the cam surface 8 will cause the shaft 8 to move axially and thereby move the bearing 36 axially in the bearing support 32. Movement of the bearing 36 causes a corresponding movement of the mesh rod 39 which compresses the spring 42. The spring 42 upon being compressed urges the starter jaw 24 into engagement with the engine jaw (not shown).

Upon the jaws meshing, the restraining force of the washer 50 will be overcome and the brass and steel washers will slip respective to each other to permit rotation of the gears 12-21. If the starter and engine jaw teeth mesh at partial depth, no appreciable torque can be applied until the cam 9 has fully advanced on the pin 10. This insures full engagement of starter and engine jaw teeth. Upon cranking an engine, should the engine jaw accelerate and push the starter jaw out of mesh, the release of the torque load from the motor will permit the armature to accelerate thus re-engaging the jaws as in initial starting.

Upon the starter being deenergized, the deceleration of the armature will tend to retract the jaws by the action of the pin 10 upon the cam surface 8 in a reverse manner from that of acceleration of the armature. This avoids or reduces the ratcheting of the starter and engine jaw which occurs when friction means are used for jaw advancement and the armature coasts to a stop.

The meshing spring 42 limits the axial force that can be applied to the jaw upon contact between the jaws and also permits the engine jaw to overrun the starter jaw. The jaw return spring 43 exerts a smaller retraction force on the jaw than is available for jaw advancement when starting, but is sufficient to insure retraction of the jaw regardless of the position in which the starter is mounted. Another feature of the starter is that the barrel 23 is connected to the jaw 24 by the clutch pack 25 thus eliminating the usual splined nut and screw shaft. Also, the gear teeth and spline teeth of the barrel 23 are the same which simplifies the manufacturing thereof.

Although only one embodiment of the invention has been illustrated and described, various changes in the form and relative arrangements of the parts may be made to suit requirements.

What is claimed is:

1. An engine starter comprising driving means, a pinion shaft, means including a cam connection for connecting said shaft for rotation with and axial movement relative to said driving means, a rotatable barrel member, reduction gearing interconnecting said barrel member and said pinion shaft, a starter jaw member, a splined clutch pack for connecting said starter jaw for rotation with and axial movement relative to said barrel member, means responsive to axial movement of said shaft for urging said starter jaw to an extended position, and means including a spring washer for restraining said reduction gearing from rotation to cause said axial movement.

2. In an engine starter, the combination of driving means having a driving member, a pinion shaft having a pinion gear integral therewith, cam means for connecting said pinion gear integral therewith, cam means for connecting said pinion shaft for rotation with and axial movement relative to said driving means, said cam means being responsive to initial rotation of said driving means to cause said axial movement, a rotatable barrel member, reduction gearing connecting said pinion gear and said barrel member, a starter jaw member, a spring biased clutch pack connecting said starter jaw to said barrel member for rotation with and axial movement relative thereto, yieldable means responsive to axial movement of said pinion shaft for urging said starter jaw to an engine engaging position, and means for retarding rotation of said reduction gearing to cause said axial movement.

3. For use in an engine starter, the combination of a driving shaft, an axially movable pinion shaft, a pin and cam slot connection between said shafts, said connection being adapted to impart axial movement to said pinion shaft to position said pin and slot for a position of engagement between said shafts, a starter jaw member, means responsive to said axial movement for moving said jaw member axially to an engine engaging position, and means for yieldably restraining said pinion shaft to cause said axial movement.

4. In an engine starter, the combination of driving means, a rotatable axially movable pinion shaft having a spiral cam groove formed in one end thereof, a pin member secured to said driving means and adapted for register in said cam
groove, a rotatable barrel member, reduction gearing connecting said pinion shaft and said barrel member, a starter jaw member, a spring biased clutch pack for connecting said jaw member for rotation with and splined for axial movement relative to said barrel member, a mesh rod member adapted for axial movement by said pinion shaft, spring means interposed between said mesh rod member and said jaw member for urging said jaw member into an engaging position upon actuation of said mesh rod member, said pin member coacting with said cam groove to move said pinion shaft axially and to provide a driving connection between said driving means and said shaft, and yieldable friction means for restraining rotation of said reduction gearing to cause said pinion shaft to be moved axially.

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