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STARTER JAW ADVANCING MECHANISM

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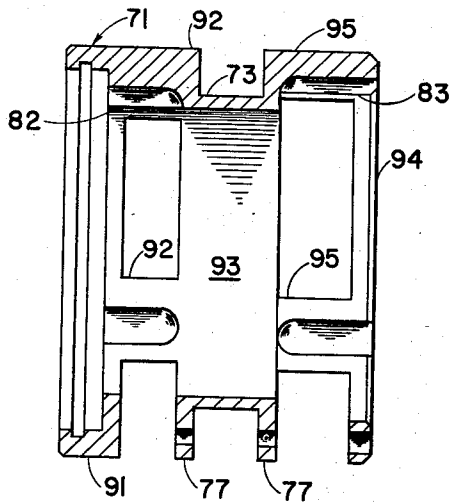


FIG. 2

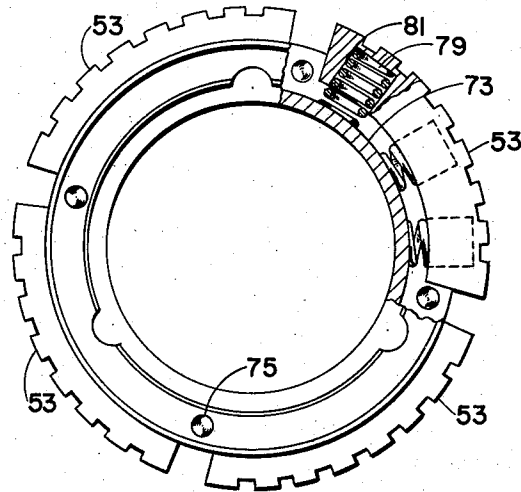


FIG. 4

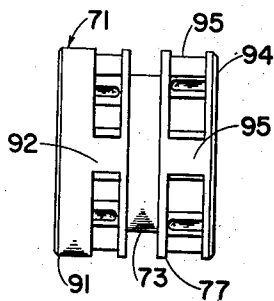


FIG. 3

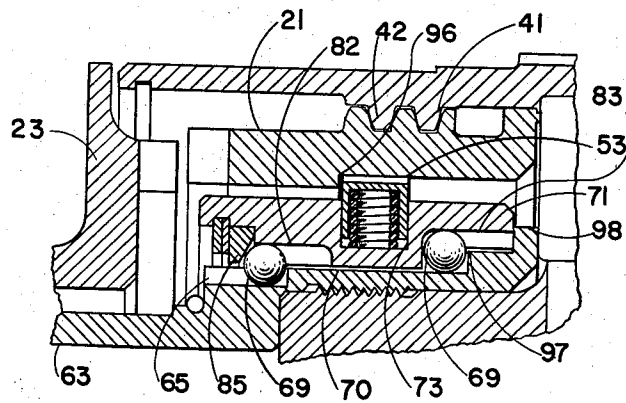


FIG. 5

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STARTER JAW ADVANCING MECHANISM

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9 Claims. (Cl. 74—7)

This invention relates to engine starters and more particularly concerns starters which have friction means for advancing the starter jaw.

In prior electric or turbine-driven engine starting equipment, the jaw advancing mechanism included a starter jaw which engaged a helical thread on the driving element and contacts a fixed friction-generating device so that it advances on the helical thread upon rotation of the driving element. The fixed friction-generating device, in addition to the required radially-directed friction force, developed friction forces acting parallel and opposite in direction to the motion of the advancing jaw. This axial friction force or drag, opposing the advancing jaw, produces a sluggishness in the motion of the advancing jaw, resulting in engagement with the load at higher rotational speeds with subsequent ratcheting and higher torque loads imposed upon the associated gearing.

The primary object of the present invention is to provide an improved starter having a jaw advancing mechanism which substantially eliminates the aforementioned sluggishness and hence imposes lower torque loads on associated gearing and reduces ratcheting.

A further object is the provision of an improved starter having a ball-mounted, friction-developing mechanism which is used to advance the engaging starter jaw.

An additional object is the provision of an improved starter arrangement incorporating an inexpensive, lightweight and easily-assembled friction generating device which is ball-mounted and safely follows the starter jaw as it advances and retracts.

The achievement of the foregoing objects and others, along with the features and advantages of the invention, will be apparent from the following description and the drawings in which:

Fig. 1 is a side view in partial cross-section of the upper and axial portions of the gear train and jaw of a combustion starter in which the present invention is embodied.

Fig. 2 is a side cross-sectional view of the annular carriage of the present invention.

Fig. 3 is a side elevation of the carriage of Fig. 2 on a reduced scale.

Fig. 4 is an end view from the right of the friction shoes and carriage and includes a cross-sectional showing of the details of one friction shoe.

Fig. 5 is an enlarged view of the jaw advancing mechanism of Fig. 1.

Referring to Fig. 1, it can be seen that the starter which embodies the present invention is basically comprised of a turbine power shaft 11 at the right which drives a two-stage planetary gear train 13, a driving annulus 15 which drives (through a spring-biased clutch pack 17) a rotatably-mounted annular member 19 and a helically-mounted, axially-advanced starter jaw 21 which engages the ring of teeth of the engine jaw 23. The turbine drive shaft is rotatably mounted in a transverse housing wall 25 and in a tubular cage member 27 which axially ex-

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tends from wall 25. Member 27 extends from the radially intermediate part of the transverse housing 25. The annulus 15 is connected to the last stage planet gears 29 which are moved by the first stage ring gear 31 and move over ring gear 32. The first stage ring gear is rotated by planet gears (not shown) which are driven by the gear 33 on the turbine shaft 11. The means for imparting rotation to the turbine shaft 11 are not shown but include an axial-flow impulse-type turbine and means for providing gases, such as a combustion chamber or a compressed air supply. The left end of the starter housing is provided with an inwardly extending flange 35 which has openings for attaching the starter to a turbine engine (not shown).

From the foregoing, it is apparent that means for transmitting torque from the turbine shaft to the annular member 19 has been provided. Annular member 19 is rotatably mounted on cage member 27 and has extending from its interior surface a helical spline 41 which mates with a helical spline 42 extending from the exterior surface of the annular starting jaw 21. The starter jaw is limited at its inner end by the outer race of the bearing 43. The starter jaw 21 has a ring of axially-extending, saw-type teeth 45 which are adapted to engage the teeth of a similar ring on the engine jaw 23. These teeth have axially-extending faces and faces inclined with respect to the axially-extending faces. A coil spring 49 is positioned in an annular space between the outer portions of the annular member 19 and the starter jaw 21. This spring 49 is confined by stop ring 51 and bears against the spline connection and normally exerts an inward force against the starter jaw 21. A plurality of friction shoes 53, 53 exerts a radially outward force against the inner surface of the starter jaw 21 so that, when annular member 19 is rotated, the starter jaw will axially advance over the helical spline for engagement with the engine jaw 23. The engine jaw 23 is adapted to be connected to a turbine engine by means of splines 55 on its axially-extending shaft part 57, the starter jaw is resiliently connected to the cage member 27 by means of shaft 59, coil spring 61 and the tubular extension 63 which is threaded on to the outer tubular portion of the cage member 27. Such a resilient mounting is described more fully in the Troeger U.S. patent application Serial No. 542,147, filed October 24, 1955. The tubular member 63 included grooves 65 and an intermediate annular surface 67 in and on which ball elements 69 roll and permit the axial movement of carriage 71 and very little friction.

The details of the jaw advancing mechanism appear more clearly in Figs. 2 to 5, wherein it can be seen that the carriage 71 has an annular groove 73 in which the four friction shoes 53 are mounted. These arcuate friction shoes are restrained from circumferential movement by means of pins 75 and extend through the four radially extending flanges 77 of the carriage 71. The brake shoes 53 are urged radially outward by a plurality of coil springs 79 which are positioned in pockets 81 of the friction shoes 53 and bear against the bottom of the groove 73. It is to be noted that each of the friction shoes have a plurality of axially-extending ridges and grooves. The carriage 71 has two sets of axially-extending grooves 82 and 83. The carriage also has a retaining ring 85 to prevent the escape of the outer rolling elements 69. It is to be noted that the carriage 71 is comprised of an outer flange 91, three webs 92 extending to the central part 93 which has the annular groove 73. The central part 93 is connected to an inner flange 94 by three webs, 95. Each of the webs 92 and 95 and the adjacent part of the flanges 91 and 94 have fairly deep grooves 82 and 83 for confining the rolling elements 69. In Fig. 5 it is to be noted that the friction shoes 53 abut an

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annular shoulder formed in the interior surface of the starter jaw 21. The tubular extension 63 has an annular surface 70 which has 3 grooves 65 for confining outer rolling elements 69. The annular shoulder 97 limits the inward movement of the inner rolling elements 69. The inner edge of the carriage 71 abuts the flange 98 of the tubular extension 63.

In one embodiment of the invention the axially-inner rolling elements 69 and their grooves 83 were omitted and the carriage was slidably-mounted, axially-inwardly on surface 70 and roller-mounted by the outer balls 69 in grooves 82.

In operation, the driving element 19 is rotated by the associated reduction gearing 13 and imparts a rotational motion to the starter jaw 21 through the mating helical thread 41, 42 machined in driving element 19 and starter jaw 21. The spring-biased, friction-generating shoes 53 develop a friction force on the inside diameter of the starter jaw 21 in direction opposite to rotation. This friction force or torsional restraint causes the jaw to advance up the inclined plane of the helical thread whereby the starter jaw moves axially. In advancing, the friction develops a reaction in the carriage 71 which causes the carriage to move axially on its low-friction balls 69 and to follow the advancing jaw 21. Since the driving member 19 slows down and comes to rest after starting speed is achieved and the power is cut off, the driven member or engine jaw 23 attached to the engine becomes the driving element and disengages the starter jaw due to the well-known separation action between the above-described teeth. The starter jaw 23 then is returned by the action of compression spring 49. The return motion of the jaw will also return the carriage 71 since the shoulder 96 on the inside diameter of the jaw 21 will engage the outer edge of the friction shoes 53. Since the carriage stop 71 will abut flange 98 of the stationary shaft portion of member 27, the carriage and jaw will be in position for the next starting cycle. It is apparent that low axial friction force is developed and that the starter jaw moves more rapidly than with prior fixed-friction designs, whereby the engine jaw is engaged at low rotational speeds. This action results in lower torque loads being imposed on associated gearing and less ratcheting between the starter and engine jaws. It is to be noted that the web structure of the carriage gives a light-weight rugged construction and that the carriage construction is easily manufactured and the arrangement conveniently assembled.

It is to be understood that changes can be made in the invention as herein shown and described, by persons skilled in the art, without departing from the invention as set forth in the appended claims.

What is claimed is:

1. In an engine starter having an engine jaw and a starter jaw which is axially advanced on helical splines of a starter drive member to engage the engine jaw, the improved starter jaw advancing mechanism comprised of friction shoes contacting said advancing starter jaw, and means carrying said friction shoes arranged so that said friction shoes axially follow said starter jaw as it is axially advanced toward the engine jaw whereby the advancing starter jaw moves more rapidly and engages the engine jaw at low rotational speeds.

2. In an engine starter having an engine jaw and a starter jaw which is axially advanced on helical splines of a starter drive member to engage the engine jaw, the improved starter jaw advancing mechanism comprised of radially-spring-biased friction shoes contacting said advancing starter jaw, said shoes being carried by a carriage, and said carriage being mounted on a stationary starter element so that said carriage moves axially with little friction when the starter jaw is advanced toward the engine jaw whereby the advancing starter jaw moves more rapidly and engages the engine jaw at low rotational speeds.

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3. In an engine starter having an engine jaw and a starter jaw which is axially advanced on helical splines of a starter drive member to engage the engine jaw, the improved starter jaw advancing mechanism comprised of radially-spring-biased friction shoes contacting said advancing starter jaw, said shoes being carried by a carriage, and said carriage being mounted by at least one set of equi-spaced ball and groove mountings on a stationary starter element so that said carriage moves axially with little friction when the starter jaw is advanced toward the engine jaw whereby the advancing starter jaw moves more rapidly and engages the engine jaw at low rotational speeds, the starter jaw having a shoulder arranged to contact said carriage upon the return of the starter jaw so that said carriage is returned to its initial position.

4. In an engine starter having an engine jaw and a starter jaw which is axially advanced on helical splines of a starter drive member to engage the engine jaw, the improved starter jaw advancing mechanism comprised of radially-spring-biased friction shoes contacting said advancing starter jaw, said shoes being carried by a carriage, and said carriage being mounted by rolling elements on a stationary element so that said carriage can move axially with little friction when the starter jaw is advanced toward the engine jaw whereby the advancing starter jaw moves more rapidly and engages the engine jaw at low rotational speeds, and spring means opposing said axial advancement and arranged to return said starter jaw and said carriage upon the engine jaw reaching starting speed.

5. An engine starter comprised of an annular driving member helically-splined to an annular starter jaw, friction-generating means contacting the inner surface of said starter jaw, said friction-generating means being mounted on an annular carriage device, said carriage device being mounted on a stationary starter shaft by rolling elements so that said means and said carriage axially follows said starter jaw when it is axially advanced through said helical spline connection due to said friction-generating means, whereby low axial friction is developed and the starter jaw moves more rapidly and can engage an associated engine jaw at lower rotational speeds with the results that lower torque loads are opposed in associated gearing and ratcheting between the starter jaw and the engine jaw is minimized.

6. An engine starter comprised of an annular driving member helically-splined to an annular starter jaw, friction-generating means contacting the inner surface of said starter jaw, said friction-generating means being mounted on an annular carriage device, said carriage device being mounted on a stationary starter shaft by ball and groove mountings so that said friction-generating means and said carriage axially follows said starter jaw when it is axially advanced through said helical spline connection due to said friction-generating means, whereby low axial friction is developed and the starter jaw moves more rapidly and can engage an associated engine jaw at lower rotational speeds, and return means arranged to return said starter jaw and said carriage after a starting cycle is completed.

7. An engine starter comprised of torque transmitting means including an annular driving sleeve which has an intermediately-located, inwardly-extending helical spline, an annular starter advancing jaw having an axially-extending ring of starter jaw teeth and an intermediately-located, outwardly-extending helical spline engaging said inwardly-extending spline, an axially-fixed engine starter jaw having a ring of engine jaw teeth arranged to be engaged by said starter jaw teeth when advanced, an annular carriage within said annular starter jaw mounted on an axially-extending stationary starter shaft, said carriage having a plurality of friction-generating shoes contacting the inner surface of said annular starter jaw for opposing rotation thereof and causing axial advancement via said helical splines, said carriage and said stationary

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starter shaft each having three equi-spaced opposed grooves in at least one end confining wall bearings whereby said carriage follows said starter jaw, and said carriage having axially extending webs in which its ball bearing grooves are partially located and which connect carriage end flanges to a central part of the carriage having an annular transverse groove in which said friction shoes are mounted.

8. An engine starter comprised of torque transmitting means including an annular driving sleeve which has an intermediately-located, inwardly-extending helical spline, an annular starter advancing jaw having an axially-extending ring of starter jaw teeth and an intermediately-located, outwardly-extending helical spline engaging said inwardly-extending spline, an axially-fixed engine jaw having a ring of engine jaw teeth arranged to be engaged by said starter jaw teeth when advanced, said jaw teeth being constructed so that axially-separation of said teeth occurs when said engine jaw attempts to drive said starter jaw, an annular carriage within said annular starter jaw mounted on an axially-extending stationary starter shaft, said carriage having friction-generating shoes contacting the inner surface of said annular starter jaw for opposing rotation thereof and causing axial advancement via said helical splines, said shoes being mounted in an intermediately-located groove in said carriage, said starter advancing jaw having a shoulder which abuts said shoes when said starter jaw is returned whereby said carriage is also returned to pre-starting position and a compression spring arranged to return said starter jaw when the engine jaw drives and disengages the starter jaw, and said carriage and said stationary starter shaft each having equi-spaced opposed grooves in at least one end confining ball bearings whereby said carriage follows said starter jaw.

9. An engine starter comprised of torque transmitting means including an annular driving sleeve which has an intermediately-located, inwardly-extending helical spline, an annular starter advancing jaw having an axially-extending ring of starter jaw teeth and an intermediately-located, outwardly-extending helical spline engaging said inwardly-

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extending spline, an axially-fixed engine jaw having a ring of engine jaw teeth arranged to be engaged by said starter jaw teeth when advanced, said jaw teeth being constructed so that axially-separation of said teeth occurs when said engine jaw attempts to drive said starter jaw, an annular carriage within said annular starter jaw mounted on an axially-extending stationary starter shaft, said carriage having a plurality of multi-toothed, arcuate friction-generating shoes contacting the inner surface of said annular starter jaw for opposing rotation thereof and causing axial advancement via said helical splines, said shoes being mounted in an intermediately-located groove in said carriage and loosely positioned by axially-extending pins to prevent rotation, said shoes each having a plurality of inwardly-opening equi-spaced circular cavities containing coil springs, said carriage and said stationary starter shaft each having three equi-spaced opposed grooves in at least one end confining ball bearings whereby said carriage follows said starter jaw, said carriage having an axial stop extension which contacts a part of said stationary starter shaft so that said ball bearings do not contact the ends of the grooves in said stationary shaft upon the return of said carriage, said starter advancing jaw having a shoulder which abuts said shoes when said starter jaw is returned whereby said carriage is also returned to pre-starting position and a compression spring arranged to return said starter jaw when the engine jaw drives and disengages the starter jaw, and said carriage having axially-extending webs in which its ball bearing grooves are located and which connect end flanges to the central part of the carriage having the annular transverse groove for said friction shoes.

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