

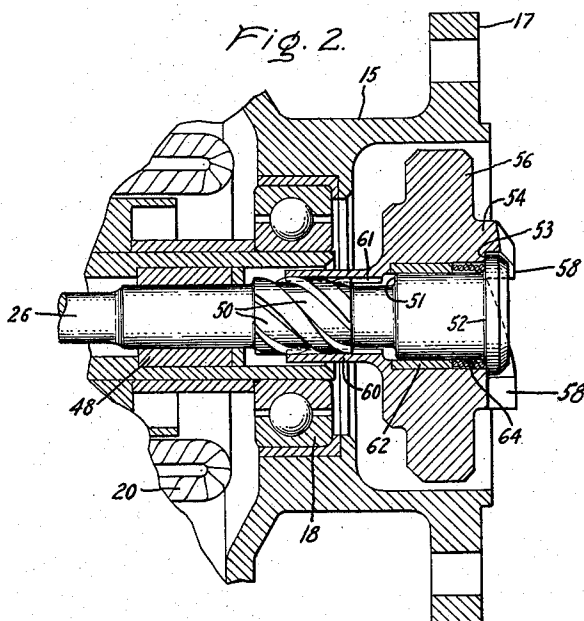
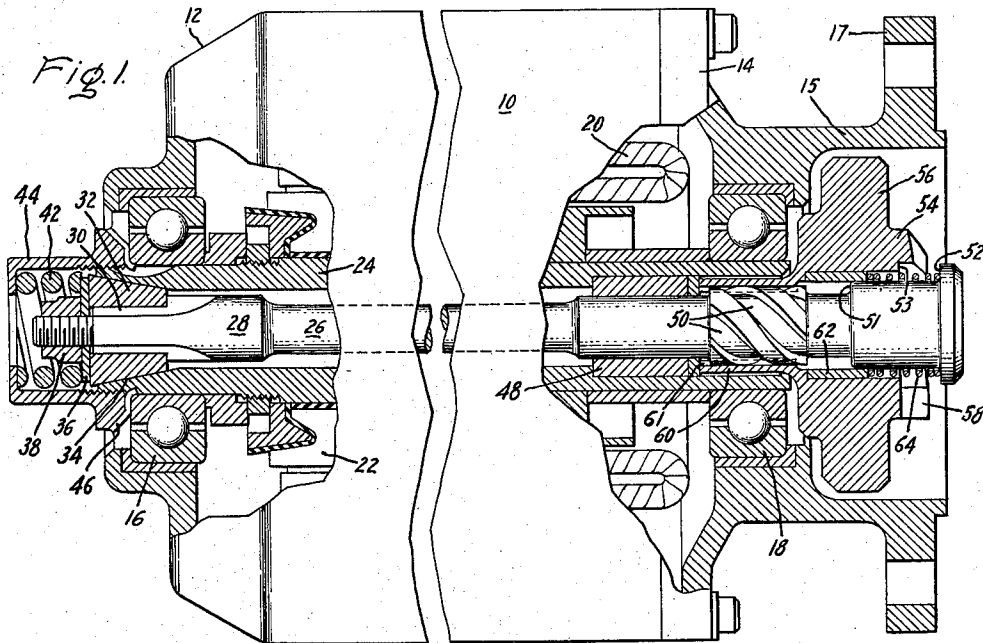
Feb. 16, 1960

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2,924,979

STARTER JAW ADVANCING MECHANISM

Filed Nov. 10, 1955



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2,924,979

STARTER JAW ADVANCING MECHANISM

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Application November 10, 1955, Serial No. 546,231

5 Claims. (Cl. 74—7)

This invention relates to electric starter drives for machines and more particularly to a starter jaw advancing mechanism utilized in starting machines and has for its object the provision of a mechanism characterized by its inherent flexibility in absorbing shock normally transmitted to the starter upon starting a machine from rest.

The inertia screw advancing type of starter commonly used in starting machines, such as an engine, has an engaging jaw on one end of the armature or quill shaft which moves outwardly into engagement with the engine upon energization of the starter motor. The abrupt jolt created by the engaging action coupled with the application of heavy load forces, as represented by the dormant engine, transmits an initial shock to the motor and creates a twisting action on the armature shaft which is not completely compensated for in starters of the prior art. Friction damping devices of various design have been incorporated in starter motors for absorbing such shock but they are invariably heavy and occupy valuable space where space is at a premium, as in an aircraft engine. Further difficulties have been encountered in obtaining withdrawal of the engaging jaw as it accelerates to an operating speed because of the engaging jaw cocks or hangs up on the armature shaft thereby preventing retraction from the engine.

In carrying out my invention, I eliminate the above-cited disadvantages by providing a flexible member positioned within and connected to a starter motor shaft through a friction coupling at one end and having an advancing jaw at its other end for engaging an engine for starting, the flexible member being constructed and arranged to absorb the shock of starting while the friction coupling acts to limit and control the extent of shock absorbed by the flexible member to a safe value. In practicing my invention in its broader aspects, it will occur to those skilled in the art that the mechanism may be incorporated in any kind of prime mover, although I specifically apply it to a motor, and the machine that it starts may be of any type susceptible of receiving its starting power from an exterior source.

For a more complete understanding of the invention, which will be more particularly pointed out in the appended claims, reference is now made to the following description taken in connection with the accompanying drawings in which:

Figure 1 is a view in elevation, partly in section, showing the arrangement of parts when the starter is in an at rest position; and

Figure 2 is a fragmentary elevational view, partly in section, showing the arrangement of parts when the engaging jaw mechanism is in an engine engaged position.

Referring now to the drawings wherein like reference characters designate like or corresponding parts throughout the several views, there is shown a starter illustrated as a dynamoelectric machine comprising a frame 10 containing appropriate magnetic field elements, not shown, and having end shields 12 and 14 respectively provided with bearing housings in which anti-friction bearings 16

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and 18 are arranged for supporting a rotatable member. The end shield 14 is equipped with a hollow extension 15 which terminates in an outwardly projecting flange 17 arranged for physically attaching the starter to an engine. The rotatable member includes armature windings 20 connected to a commutator 22 which are mounted on a hollow armature or quill shaft 24 extending centrally through the rotatable member.

A flexible inner shaft or torque rod 26 is positioned concentrically within the quill shaft 24 and is provided with an upstanding collar 28 adjacent an end thereof as shown in Figure 1. In order to provide a driving connection between quill shaft 24 and torque rod 26 which will absorb sudden shocks, a friction clutch or coupling is provided on the outboard end of the torque rod and is arranged to coact with the inner peripheral surface of quill shaft 24.

In the preferred form, the friction coupling comprises a set of splines 30 formed on the end of the torque rod for receiving a cone damper 32 having an outer surface arranged for frictional contact with the inner peripheral surface of quill shaft 24. The cone damper 32 is firmly positioned on the end of the torque rod by a plate 36 pressed against the cone damper by a nut 38. In order to position the cone damper in firm frictional relationship with the inner surface of the quill shaft, a biasing spring 42 is located between plate 36 and a spring tension adjusting cap 44 screw-threadedly attached to the end of the quill shaft. It will be evident that the degree of frictional contact between the cone damper 32 and quill shaft 24 is governed by the extent of compression of spring 42. After the spring is initially compressed, the degree of compression would normally not be changed; however, it would be possible to make such a change by merely turning the adjusting cap 44 in the desired direction. The cap is prevented from moving relative to shaft 24 by a locking ring 46 having tabs which are bent over in locking engagement with the cap.

The engaging end of the mechanism comprises a bearing member 48 arranged for aligning the torque rod within the quill shaft 24. The torque rod is provided with a plurality of spiral grooves 50 and terminates in integrally formed shoulders 51 and 52 machined on an end thereof. A hollow engaging jaw 54 arranged for longitudinal and rotary movement on the end of the torque rod, comprises a weighted portion 56 having engine engaging dogs 58 formed on its outer end for contacting mating grooves fixed in an end of the engine. The cylindrical end 60, opposite from the dogs, fits within the hollow quill shaft and is provided with internal spiral threads 61, welded or otherwise affixed to the inner cylindrical surface, arranged to ride in the spiral grooves 50 when the torque rod is rotated by the motor, thereby simultaneously imparting longitudinal and rotary motion to the engaging jaw 54.

Jamming or a hanging up of the engaging jaw on the torque rod during either an engaging or retracting action is prevented by a jaw aligning bearing 62 pressed in an end of the engaging jaw and being of a diameter just sufficient to permit easy sliding movement on the surface appearing between shoulders 51 and 52. The engaging jaw 54 is held squarely on the torque rod 26 by the bearing 62 and by the top of the spiral threads on the torque rod which coact closely with the cylindrical end 60 and threads 61 formed thereon. The coacting threads essentially form a bearing similar to bearing 62, for providing a smooth fit with a minimum of radial play throughout all axial positions of the engaging jaw.

In order to return the engaging jaw 54 to its retracted position, a biasing spring 64 bearing between an end of the aligning bearing and shoulder 52 exerts sufficient

force to retract the engaging jaw as soon as the engine becomes self-supporting. At the precise moment of disengagement, no torque is being transmitted across the jaws, that is, from the starter motor to the engine and vice versa, thereby enabling the spring to separate the engaged members. This action will take place even though the starter may continue to run at full speed. It is to be noted that continued running of the starter, even at full speed, will not advance the jaw to an engaged position since the jaw is moved only during an initial acceleration period.

Operation

In operation, energization of the dynamoelectric machine causes torque to be transmitted through the quill shaft 24, cone damper 32, torque rod 26 and engaging jaw 54 to an engine or other machine arranged for starting. Upon initiation of rotation of the torque rod, the threads 61 on the cylindrical end of engaging jaw 54 are caused to travel in the spiral grooves 50 thereby causing the engaging jaw to move laterally to the right against the force of spring 64. The jaw reaches its extended position when shoulder 52 is in firm contact with the flat seat 53 formed on the outer end of jaw 54 and, at this time, the dogs 58 are in a position to effectively transmit torque from the starter to the engine.

It will be evident that motors employed for starting engine or other machines from rest have extremely high starting torques and as a consequence, the engaging jaw is accelerated at a high rate and is caused to contact its mating part in the engine with an impact that, in this structure, is due only to the inertia of the engaging jaw and not the complete starter armature. This engaging jaw inertia effect is of very short duration, lasting a period of time necessary for the establishment of firm contact between surfaces 52 and 53 and proper engagement of the jaw with the engine. At this instant, the starter motor will be at or near full speed while the engine is at a standstill and in order to absorb the instantaneous shock transmitted to the starter, the torque rod 26 will twist a sufficient amount to dissipate the force which in prior art devices might shear the shaft. The limit of torque rod twist is controlled to a safe value by the friction clutch or coupling which simultaneously transmits the full output torque of the starter motor. A unique function performed by the torque rod and friction coupling, as opposed to devices utilizing friction clutches only, is that the shock wave starts from zero, since all spring loadings start from zero, and builds up to a predetermined limit. A pure friction device on the other hand, starts with full impact shock equivalent to the friction setting which contributes to severe wear of the engaging jaws and supporting mechanism. Thus it will be seen that friction actually is used to dampen the shock and vibrations generated in this system. The shock absorption devices or means employed for achieving this damping effect reside in the flexible torque rod and the cone damper, both of which are positioned within the confines of the hollow shaft. The torque rod twists upon the abrupt application of a load thereto and thereby dissipates some of the energy, as explained above, while the cone damper limits and controls the amount of shaft twist to a safe value, the result being that adverse forces normally transmitted to the rotor, as in the prior art structures, are damped and severely limited by the shock absorption devices acting in the manner described above.

A cocking action of the engaging jaw on the torque rod or quill shaft, resulting in a jamming of the mechanism, is prevented by virtue of the machined surfaces provided on the coating parts thereby assuring proper engagement and retraction under all conditions of operation as explained above.

Obviously many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the

scope of the appended claims the invention may be practiced otherwise than as specifically described.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A starter jaw advancing mechanism for use with a prime mover utilized in starting a machine comprising a hollow shaft arranged to transmit torque supplied by said prime mover and a flexible torque rod concentrically positioned in said hollow shaft, friction damping means mounted on said torque rod and interconnecting one end thereof with an internal surface of said shaft, a major portion of said damping means being wholly positioned within said shaft, and spring means permanently biasing said damping means into frictional sliding contact with the internal shaft surface so that slippage between said torque rod and shaft will occur when the relative turning forces therebetween exceeds the frictional forces presented by the damping means, an engaging jaw slidably mounted on said torque rod at its other end for transmitting torque from said hollow shaft and torque rod to said machine, and centering means comprising mutually coating bearing surfaces on said engaging jaw and said torque rod for providing smooth and uninterrupted movement of said engaging jaw into engagement with said machine in response to actuation of said torque rod.

2. A starter jaw advancing mechanism for use with a prime mover utilized in starting a machine comprising a flexible torque rod having its torsional length concentrically positioned wholly within a hollow shaft connected with said prime mover, friction damping means interconnecting one end of said torque rod with said hollow shaft, said damping means comprising a cone damper affixed to said torque rod and having an outer surface in frictional contact with the inner peripheral surface of said hollow shaft, an engaging jaw spring biased to a disengaged position on the other end of said torque rod projecting slightly beyond the end of said shaft and arranged to be thrown outwardly into engagement with said machine upon rotation of said torque rod, and combined stop and centering means comprising coating bearing surfaces respectively fixed on said engaging jaw and said torque rod for providing limited movement and uninterrupted engagement and retraction of said engaging jaw with said machine.

3. The combination according to claim 2 wherein said friction damping means further comprises a spring tension adjusting cap detachably mounted on an end of said hollow shaft, and a retaining spring positioned between said cap and said cone damper for urging said damper into frictional engagement with said inner peripheral surface of said hollow shaft with a force corresponding to the amount of tension created in said spring by the adjusting cap.

4. An electric starter for use in starting machines comprising a hollow shaft supporting a rotor for a dynamoelectric machine, a flexible torque rod concentrically positioned within said hollow shaft and friction damping means interconnecting one end of said torque rod with the inner peripheral surface of said hollow shaft so that upon rotation of said rotor torque is transmitted through said hollow shaft and said friction damping means to said torque rod, an engaging jaw on the other end of said torque rod arranged to be thrown outwardly into engagement with said machine upon rotation of said rotor, said engaging jaw comprising a weighted member having spaced dogs on one end thereof adapted for engagement with said machine, an axially extending cylindrical portion having internal spiral grooves formed on the other end of said member engaged with mating spiral threads formed on the outer surface of said torque rod, said mating grooves and threads comprising coating bearing surfaces assuring constant alignment of said engaging jaw with said torque rod and being capa-

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ble of providing smooth and uninterrupted axial movement of the engaging jaw with said machine and biasing means coacting with said torque rod and said engaging jaw for biasing the latter into a disengaged position.

5. The combination according to claim 4 wherein said torque rod is provided with stop means integrally formed thereon and engageable by said engaging jaw when the latter is thrown outwardly for engagement with said machine.

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