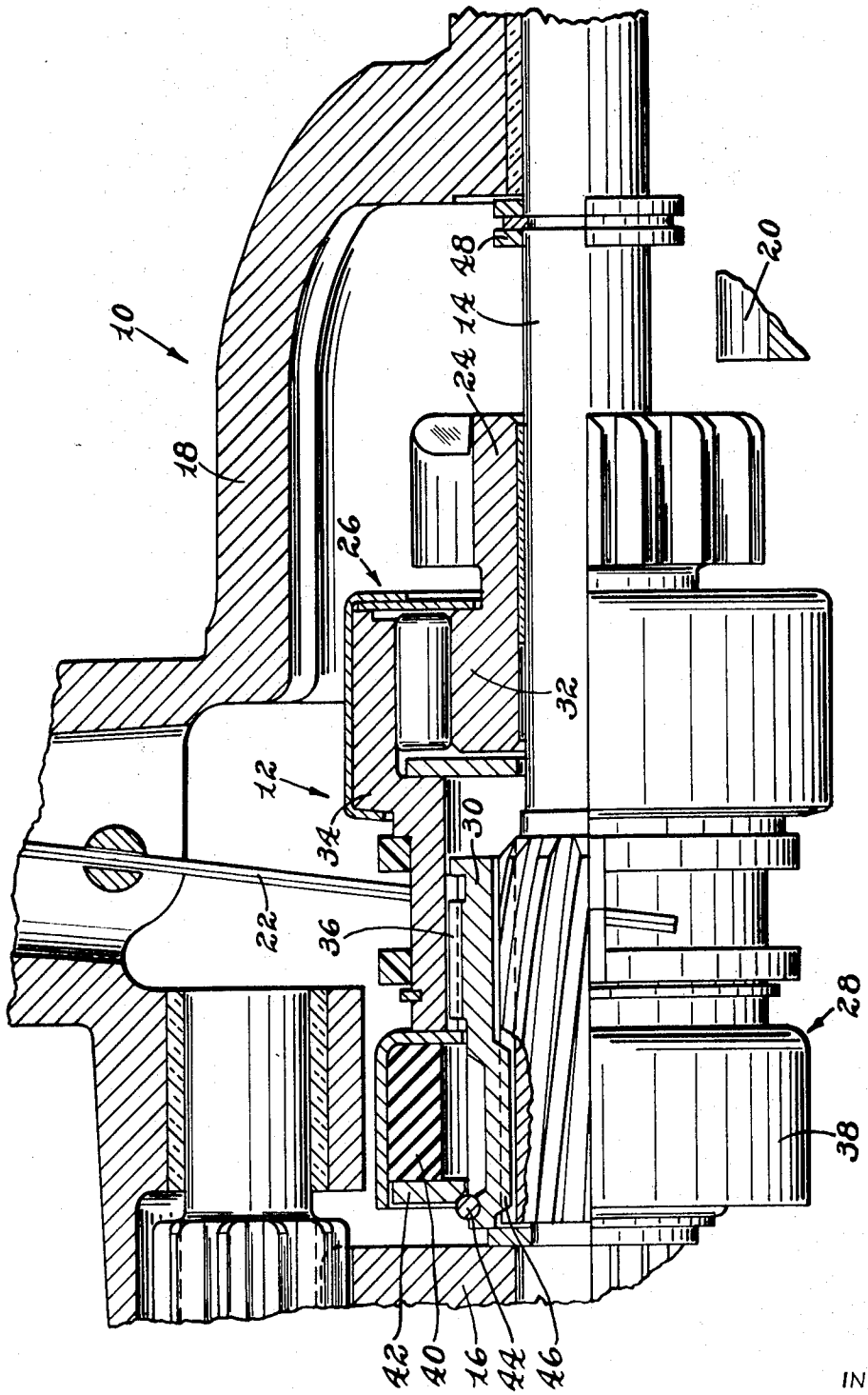
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ROLL CLUTCH STARTER DRIVE WITH SHOCK ABSORBER

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ROLL CLUTCH STARTER DRIVE WITH SHOCK ABSORBER

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ABSTRACT OF THE DISCLOSURE

A roll clutch starter drive is provided with a compressible cushion member compressed by axial translation of a splined sleeve to reduce the peak torque applied to the components of the starter drive and to extend the service life of the starter motor and drive.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to the art of coupling motors to internal combustion engines for rotary starting of the internal combustion engine, and particularly to that class of starter drives termed "roll clutch" starter drives.

Prior art

The evolution of internal combustion engines and the starting systems used in conjunction therewith has established two criteria for the starter drives which interface between the starting system and the internal combustion engine which can currently be met by only one type of starter drive. The roll clutch starter drive is the only type of starter drive which provides the quiet operation and low wear resulting in long life suited to automotive use. However, as the evolution of internal combustion engines has produced a steady increase in the size (displacement) of the engines, the performance demands placed on the starting system have also increased. The torque output of the starting motor has been steadily raised so as to provide sufficient torque, termed "stall torque," to initiate movement of the ring gear of the internal combustion engine yet the roll clutch starter drive has not grown in size and as a consequence, has been less and less able to accommodate the high peak, or reaction torques which are developed as a result of the increased engine sizes. Starter drives, other than roll clutch starter drives, which are able to efficiently handle these torque levels are currently unacceptable for domestic automotive application because of their high initial cost, high wear rate, and the high noise levels generated when in operation. The roll clutch starter drive, on the other hand, is relatively quiet in operation has low wear rates, occupies less space, and is less expensive making it the preferred starter drive.

The roll clutch starter drives rely upon the natural resiliency of the outer race member, rollers, and inner race surfaces in the roll clutch to absorb the peak torques to which the starting system is subjected. Peak torque is that torque which must be absorbed by the starting system due to the fact that energy developed within the system as the starting motor accelerates the pinion into mesh with the ring gear must be dissipated when the starter motor speed is rapidly decelerated as a consequence the rest condition of the ring gear. However, as the peak torques increase, the chances of an early metal fatigue failure increase causing the life expectancy of the roll clutch starter drives to drop quite drastically. While these drives are individually inexpensive, the need for their replacement at a comparatively early date makes their total cost unattractive. It is, therefore, an object of the present invention to provide an improved roll clutch starter drive having an extended life potential. It is a further object of the present invention to provide a roll clutch starter drive having a high stall torque characteristic and a low peak torque characteristic. It has been found that a slight reduction of peak torque will greatly increase the service life of the device. It is, therefore, an object of the present invention to provide a roll clutch starter drive having a lower peak torque characteristic than roll clutch starter drives of comparable size and torque transmitting capability.

SUMMARY OF THE PRESENT INVENTION

In a roll clutch starter drive according to the present invention, a sleeve member is situated intermediate the outer race of the roll clutch and the shaft of the starter motor and is interconnected to each by a pair of spline connections. The spline connections are biased to axially opposed extremes when the starter system is not energized. Resilient means are provided in biasing one of the spline connections to permit telescoping movement of one of the spline connections in opposition to the resilient bias when a peak torque situation is encountered to thereby absorb a portion of the peak torque and, therefore, reduce the peak torque applied to the system. The resilient means are arranged to maintain one of the spline connections relatively immovable until a peak torque is encountered and then to control relative movement of the splines.

BRIEF DESCRIPTION OF THE DRAWING

The single figure of the drawing illustrates the present invention as applied to a starting system using a positive shift roll clutch starter drive.

DETAILED DESCRIPTION

Referring now to the drawing, the present invention is illustrated with regard to a positive shift starting system **10**. The starter drive **12** is mounted on shaft **14** of a starter motor means, shown fragmentarily at **16**, having a casing **18**. The drive **12** is shifted on shaft **14** into and out of engagement with the ring gear **20** of an engine to be started, not shown, by advancement means shown here as shifting lever **22**. The shifting lever **22** may be controlled in the usual manner, as by a solenoid, and is intended to be also illustrative of shift advancement means and mechanisms such as those illustrated in United States Letters Patent 3,299,719, issued in the name of P. Toulier and United States Letters Patent 3,465,353, issued in the name of J. E. Buxton et al.

The starter drive **12** is comprised of the ring gear engaging pinion **24** which is connected to the uni-directional roll clutch **26**, the shock absorbing means **28** and the coupling member or sleeve **30** coupled to the shaft **14**. The pinion **24** is connected to the inner race **32** of the roll clutch **26** while the outer race **34** is coupled by spline connection **36** to the sleeve **30**. The shock absorber is comprised of cup shaped retainer means or member **38**, resilient shock absorbing member **40** and rigid abutment member **42**. The resilient shock absorbing member is, in the preferred embodiment, a compressible annulus of resilient material such as rubber, but other materials and other configurations are possible. The shock absorber means **28** is arranged to bias the spline connection **36** in a direction of maximum extension so that the outer race **34** and hence, the pinion **24**, is at its axially rightmost extreme position relative to the sleeve member **30**. Abutment member **42** is axially positioned, relative to the coupling member **30**, by the resilient means **40** and lock ring **44** and the resilient means **40** are operative to bias retainer means **38** into axial abutment with the outer race **34** of the roll clutch means **26** to provide an axially fixed connection therewith.

Sleeve member **30** is coupled to the shaft **14** through a second spline connection **46**. When the drive is not in use, the spline connection **46** is biased in a direction of

minimum extension by means shown here as the shift lever **22**. Spline connection **46** is shown as a helical spline since a suitably directed helical spline connection between the shaft **14** and starter drive **12** will aid meshing between the pinion **24** and ring gear **14** through screw-jack action.

At least one of the spline connections **36, 46** must be a helical spline so that a peak torque condition can generate an axial thrust, through screw-jack action, sufficient to act against the bias applied by the resilient means **40**. The other of the spline connections should not inhibit the sliding movement required to act against the bias of the resilient means **40**. It has been determined that the second spline connection may be a straight or helical spline, and if helical, may be of variable lead and of the same or opposite direction as the first spline connection. Lead in this instance should be understood to mean the axial length of a shaft required for a spline to make one complete turn around the shaft, with a straight spline having infinite lead.

OPERATION

Under comparatively low torque situations, the shock absorber means **28** and the spline connection **36** behave as an axially solid connection between the outer race **34** of the roll clutch and the sleeve member **30**. Immediately following engagement of the ring gear **20** by the pinion **24**, the amount of torque being transmitted through the starter drive will begin to rise to a high peak value due to the high speed of the starter motor and the at rest inertia of the engine. In the prior art type of drive, the peak could easily exceed 100 lb. ft. of torque. This would tend to cause a slight elastic deformation of the roll clutch **26** and particularly of the outer race member **34**. This would eventually lead to a metal fatigue failure of the roll clutch rendering the device inoperative and necessitating a time consuming, inconvenient, and expensive repair. For larger displacement engines, the peak torques are proportionally higher but the fatigue factors increase as multiples thereby reducing the statistical life of the drive by factors as high as 10. However, with a roll clutch drive according to my invention and upon the occurrence of a peak torque condition, the resilient means **40** will be acted upon by the rigid member **42** and by cup member **38** to absorb energy when torque begins to peak. This serves to reduce or eliminate the peak torque levels.

As rotating pinion **24** engages the stationary ring gear **20**, the rotation of the pinion **24** and of the starter drive **12** relative to the shaft **14** will be impeded. This will generate a rightward thrust, relative to the drawing, on the starter drive **12** as a result of the screw-jack action at the helical spline connection **46**. The drive will be rapidly urged into full engagement of the pinion **24** with the ring gear **20** until pinion **24** abuts the stop means **48** on the shaft **14**. Since the drive **12** can no longer advance, the drive will attempt to rotate with the shaft. Because the ring gear **20** has a high moment of inertia and will attempt to remain stationary, a peak torque situation is encountered. At some selectably high torque level, the axial thrust on the sleeve **30** as a result of the screw-jack action at the spline connection **46** will be sufficient to overcome the bias of the resilient means **40** and the sleeve **30** will again advance rightward causing a deformation of the resilient member **40**. The resilient member **40** is, in this instance, a compressible annulus of rubber or the like material. As the resilient member is compressed, the spline connection **36** will begin to telescope. As the resilient member **40** continues to be compressed, the amount of torque applied to the roll clutch, and therefore, available to subject the roll clutch to metal fatigue situations, will be substantially reduced. Depending upon the resiliency of the compressive member **40**, the torque value at which compression occurs can be controlled and a substantial increase in starter drive life can be achieved. For instance, I have found that peak torque in two otherwise identical starter drives can be reduced from about 122 lbs. ft. to about 92 lbs. ft. (a reduction of 25%) through the practice of my invention with spline connection **46** being helical and spline connection **36** being straight.

Virtually any combination of spline connections may be used in the practice of my invention. However, the best results which I have obtained have been obtained with a comparatively short lead in the spline connection **46** between the shaft **14** and the sleeve **30** and a slightly longer lead in the spline connection **36** between the sleeve member **30** and the outer race **34** of the roll clutch and both spline connections were in the same direction. This is believed to occur as a result of improved mechanical advantage serving to initiate compression of the resilient member at lower torque levels so that greater amounts of torque energy are absorbed thereby further lowering peak torque. In one instance, reduction of the lead of spline connection **46** from 16 inches to 6 inches in a starter drive according to my invention served to produce a further reduction in peak torque of 15% (based on the initial figure of 122 lbs. of torque).

I claim:

1. In combination with a roll clutch starter drive of the type having a pinion, a uni-directional roll clutch means, advancement means operative to advance the pinion into engagement with the ring gear of an engine to be started and coupling means operative to provide a means for connecting the starter drive to a source of rotary power, the improvement comprising shock absorbing means interconnecting said roll clutch means and said coupling means operative to provide an axially substantially rigid connection therebetween at levels of transmitted torque below a predeterminable level and further operative to deform and thereby absorb torque at torque levels above the predeterminable level, said coupling means comprising a sleeve member having splines adapted for coacting with mating splines on a rotary shaft of a starter motor means, the starter motor means being the source of rotary power, and said shock absorbing means comprising resilient means, means providing a substantially axially fixed connection between said resilient means and said sleeve means and means providing a substantially axially fixed connection between said resilient means and said roll clutch means, said resilient means being deformable to vary the axial relationship between said sleeve member and said roll clutch means.

2. In combination with a roll clutch starter drive of the type having a pinion, a uni-directional roll clutch means, advancement means operative to advance the pinion into engagement with the ring gear of an engine to be started and couplig means operative to provide a means for connecting the starter drive to a source of rotary power, the improvement comprising shock absorbing means interconnecting said roll clutch means and said coupling means operative to provide an axially substantially rigid connection therebetween at levels of transmitted torque below a predetermined level of torque and further operative to deform and absorb torque at torque levels above the predetermined level, said shock absorbing means comprising resilient means providing an axially variable connection between said coupling means and said roll clutch means, said resilient means requiring a generated force above a predetermined minimum prior to variation of said axially variable connection, said minimum generated force being indicative of torque above a selected level, said resilient means comprising fixed means connected to said coupling means, retaining means, and a resilient member confined between said fixed means and said retaining means and operative to bias said retaining means into an abutting relationship with said roll clutch means, and said coupling means are connected to said roll clutch means by splines and said resilient means are operative to urge said roll clutch means toward a position of maximum axial extension.

3. A starter drive comprising:
coupling means adapted for connection to the output shaft of a motor means;
pinion means adapted for engagement with the ring gear of an engine to be started;
roll clutch means connected to said pinion means operative to provide a uni-directional torque transmitting connection between said coupling means and said pinion means; and
resilient means interconnecting said roll clutch means and said coupling means operative to be deformed when the level of transmitted torque exceeds a selected value;
said coupling means being connected to said roll clutch means by splines; and
said resilient means operative to yieldably bias said roll clutch means to a position of maximum axial extension of said roll clutch means relative to said coupling means.

4. The starter drive as claimed in claim 3 wherein said coupling means comprise an axially-extended sleeve member and including further:
abutment means arranged for cooperation with said sleeve member and resilient means and operative to establish an axially fixed position of said resilient means relative to said sleeve member;
said resilient means engaging said abutment means and operative to urge said sleeve member toward said fixed position; and
retainer means engaging said roll clutch means and engaging said resilient means whereby said resilient means are confined between said retainer means and said abutment means.

5. In combination with a starter drive of the type having a pinion, a radially acting uni-directional clutch means, advancement means operative to advance the pinion into engagement with the ring gear of an engine to be started and coupling means operative to provide a means for connecting the starter drive to a source of rotary power, the improvement comprising shock absorbing means interconnecting said clutch means and said coupling means operative to provide an axially substantially rigid connection therebetween at levels of transmitted torque below a predetermined level and further operative to deform and thereby absorb torque at torque levels above the predeterminable level, said coupling means comprising a sleeve member having splines adapted for coacting with mating splines on a rotary shaft of a starter motor means, the starter motor means being the source of rotary power, and said shock absorbing means comprising resilient means, means providing a substantially axially fixed connection between said resilient means and said sleeve means and means providing a substantially axially fixed connection between said resilient means and said clutch means, said resilient means being deformable to vary the axial relationship between said sleeve member and said clutch means.

6. A starter drive comprising:
coupling means adapted for connection to the output shaft of a motor means;
pinion means adapted for engagement with the ring gear of an engine to be started;
radially acting clutch means connected to said pinion means operative to provide a uni-directional torque transmitting connection between said coupling means and said pinion means; and
resilient means interconnecting said clutch means and said coupling means operative to be deformed when the level of transmitted torque exceeds a selected value;
said coupling means connected to said clutch means by splines; and
said resilient means operative to yieldably bias said clutch means to a position of maximum axial extension of said roll clutch means relative to said coupling means.

7. The starter drive as claimed in claim 6 wherein said coupling means comprise an axially-extending sleeve member and including further:
abutment means arranged for cooperation with said sleeve member and resilient means and operative to establish an axially fixed position of said resilient means relative to said sleeve member;
said resilient means engaging said abutment means and operative to urge said sleeve member toward said fixed position; and
retainer means engaging said roll clutch means and engaging said resilient means whereby said resilient means are confined between said retainer means and said abutment means.

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