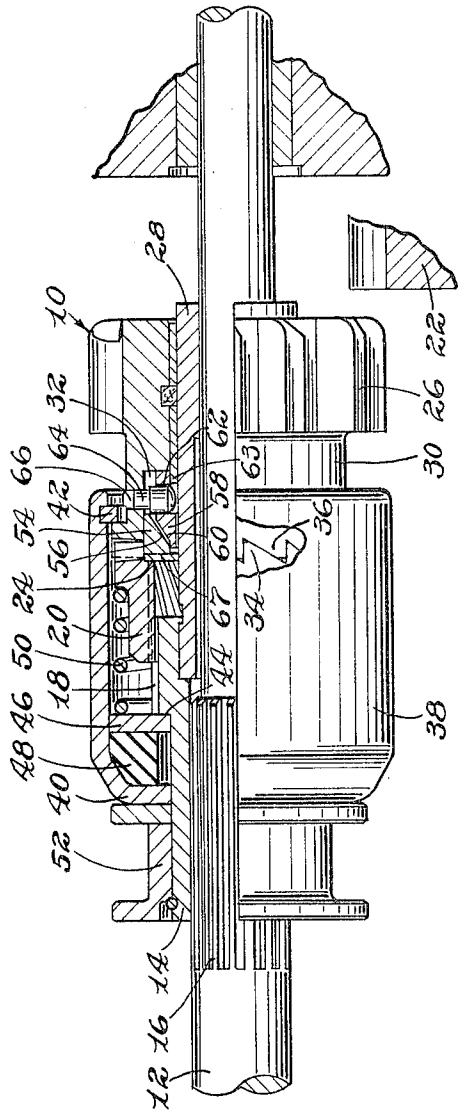
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ENGINE STARTER GEARING

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WITNESS:

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ENGINE STARTER GEARING

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The present invention relates to engine starter gearing for an engine and more particularly, starter gearing of the positive shift type, including a dentil clutch to provide driving and overrunning and further including means for effecting the automatic separation of the clutch teeth after the engine becomes self-running.

The present invention is an improvement over the starter gearing system described in co-pending, commonly-assigned United States patent application Serial No. 269,434, entitled, "Engine Starter Drive," filed April 1, 1963, now Patent No. 3,181,375, having as an inventor John J. Sabatini.

It is an object of the present invention to provide an improved starter drive of the type referenced, having automatic means for separating dentil clutch teeth after engine start-up which is reliable and relatively inexpensive to manufacture.

It is another object of the present invention to provide an improved starter drive having centrifugal weight and thrust washer means for separating dentil clutch teeth after engine start-up to prevent long periods of clutch over-running and accompanying deleterious wear.

It is a still further object of the present invention to provide an improved starter drive with centrifugal weight clutch separator means having means for mounting the centrifugal weights to avoid erratic action, to guard against dislodging the weights due to impact, to avoid inadevertent cocking of the weights while utilizing a form of construction adaptable to low cost manufacturing techniques.

Other objects and advantages will become apparent on consideration of the accompanying description and drawing.

Referring to the drawing, there is illustrated a starter drive for an engine generally designated by numeral **10**, mounted on a power shaft **12** of a starting motor (not illustrated). The drive includes an axially-extending sleeve **14** connected to shaft **12** by straight splines **16** so as to be axially, but not rotatively, movable relative to the shaft. The external surface of the forward or right-hand extremity of the sleeve has helical splines **18** formed thereupon which a driving clutch member **20** is threaded and adapted for movement toward and away from a gear **22** of the engine to be started. The driving clutch member in its engaged position as illustrated, projects past the right end of sleeve **14** so that the right-most edge of the splines form a radially-inwardly-extending shoulder **24** for a purpose to be later described.

A pinion gear **26** is slidably journalled on bearing **63**, which in turn, is mounted on a sleeve **28**. Sleeve **28** is secured to sleeve **14** and is slidably supported on a reduced diameter extension of power shaft **12**. The pinion gear is adapted for movement into and out of engagement with the engine gear **22**. An annular driven clutch member **30** is integrally formed with the pinion gear as the left-most extension thereof, as illustrated in the drawings. The driven clutch member is formed to provide an annular or circular recess **32** radially inwardly of the clutch member having its inner extremity defined by sleeve **28**.

The opposing or adjacent faces of the clutch members **20** and **30** are provided with complementing mutually engageable inclined torque transmitting dentil teeth **34** and **36**, respectively. The dentils are of the saw-toothed variety to provide a one-way overrunning clutch connection.

A barrel-shaped housing **38**, having a closed and an open end, is slidably supported at its closed end **40** on the external surface of sleeve **14**. A lock ring **42** is seated in a notch adjacent the open end of the housing and has sufficient radial length to engage driven clutch member **30** to thereby confine the clutch elements within the housing cavity.

The sleeve **14** is provided with a radial shoulder **44** intermediate its extremities to provide an abutment for a disc or washer **46** slidably journalled on the sleeve. A resiliently-yieldable cylinder **48**, preferably of an elastically-deformable material, such as rubber, is compressively confined between the disc and closed housing end. A resilient spring member **50** is compressively confined between disc and driving clutch member to provide a biasing force, urging the clutches in an engaged position.

Means for moving the starter gear assembly toward or away from the engine gear **22** may comprise the conventional solenoid, air or hydraulic cylinder actuated lever, not illustrated, connected to the shift collar **52** which is connected to the closed end **40** of housing **38**.

Means for accomplishing the automatic separation of dentil teeth **34** and **36** are arranged in the annular recess **32** within the driven clutch member **30**. An annular thrust washer **54** backed by a loose thrust washer **67** abuts at its outer edge the shoulder **24** of driving clutch member **20**. The radially-inner surface **56** of the thrust washer is inclined or conically-formed with respect to the longitudinal axis of the starter gear. A plurality of arcuate centrifugal flyweight members are annularly arranged adjacent thrust washer **54**, one such flyweight is designated by the numeral **58**. Each flyweight has an inclined surface **60** complementary with and abutting surface **56** of the thrust washer. A radial hole **62** is formed in each weight at an intermediate or mid-point closely corresponding with the location of center of gravity of the weight member. A support pin **64** is secured on one end in a radial hole **66** formed in annular driven clutch member **30** and projects radially inwardly therefrom into the hole **62** in the flyweight member. The pin and hole connection restrain the flyweight from movement in either the axial or circumferential direction, while permitting radial movement in response to centrifugal force. It will be noted that sleeve bearing **63** projects into the annular recess **32** and provides a radially-inward stop for the flyweight **58**, establishing clearance between flyweight and sleeve **28** to avoid wear or snagging of the moving assembly.

In operation, when it is desired to crank the engine, the starter gearing assembly is shifted to the right via positioning mechanism connected to collar **52** and along the power shaft **12** so that pinion gear **26** engages engine starter gear **22**. Shaft **12** is rotated by a starting motor and transmits torque through splines **16** to sleeve **14**, from helical splines **18** to the driving clutch **20**, driven clutch **30**, pinion **26** to the engine gear. As the engine fires and becomes self-operating, engine gear **22** will now drive pinion **26** at a speed greater than that of the shaft **12**. Clutch teeth **34** and **36** will slip so that the starting

motor is not driven at high engine speed. This condition formerly has caused severe wear of the dentil teeth where overrunning continues for prolonged periods as the relatively heavy clutch engagement spring **50** urges the clutch teeth towards the engaged position while the overrunning cam action between the teeth forces them apart. The result is clashing and severe impact on the teeth. In the present invention, however, as the engine accelerates, it will drive the flyweights **58** through support pins **64**, driven clutch **30**, and pinion **26**. The weights will tend to move radially outwardly, guided by pins **64** and will transmit axial thrust through the inclined surfaces **60** and **56** to the thrust washer or ring **54**. Thrust washer **54** is urged to the left and through its abutting connection through loose washer **67** at shoulder **24** and will displace the driving clutch member **20** to the left against the biasing force of spring **50**, causing separation of the clutch teeth at a predetermined engine self-operating speed. This action, of course, prevents the dentil teeth from being subject to long periods of contact while the pinion is overrunning.

The starter gearing is further designed to provide an indexing function should the pinion **26** abut one of the teeth of starter gear **22** when being actuated to the right into engagement. In such an event, pinion movement is obstructed by tooth abutment, but the shifting mechanism will continue to shift housing **38**, sleeves **14** and **28**. In an abutment, pinion and clutch stand still against ring gear while drive sleeves **14** and **28** and case **38** continue to shift rightwardly toward the ring gear. Thus, the pinion and clutch members will shift leftwardly relative to sleeve **14**. Driving clutch **20** will be caused to rotate on helical splines **18** which rotation is transmitted to driven clutch **30** and pinion **26** through the dentil teeth so that the pinion will clear the obstructing tooth on engine gear **22**. As the tooth is cleared, spring **50** snaps the pinion and clutch members to the right in the engaged position.

The starter gearing mechanism accomplishes all the normal functions of impact cushioning, indexing, overrunning, and in addition, provides automatic dentil tooth separation, greatly increasing starter gear life. Manufacturing is readily accomplished as the annular recess **32** is a simple cylindrical configuration and pin support holes are formed by conventional drilling operation. The pin and hole mounting of weights **58** tends to prevent tipping of the weights as they fly outward and retains the weights in position so they cannot escape if the clutch members bounce apart due to impact during overrunning.

I claim:

1. Engine starter gearing comprising:

a power shaft;

a sleeve slidably, but non-rotatably, secured to said power shaft, said sleeve having external helical splines formed on one extremity thereof;

a pinion gear slidably journalled for axial movement relative to the power shaft adapted for movement into and out of engagement with a gear of the engine to be started;

an annular driven clutch member secured to said pinion gear for movement therewith and forming a circular recess radially inwardly of said driven clutch member;

a driving clutch member slidably mounted on said helical splines of said sleeve;

said driving and driven clutch members having complementary mutually-engageable inclined teeth for transmitting torque therebetween in one direction of relative rotation;

a barrel housing having an open end, slidably supported on said sleeve and spatially encompassing said clutch members;

abutment means within the housing adjacent the open end thereof adapted for engagement with the driven clutch member for confining the clutch members within the housing;

resilient means within said housing abutting said driving clutch member and biasing said clutch members into engaged position;

said driving clutch member having a radially-inwardly-extending shoulder formed thereon adjacent said circular recess formed in said driven clutch member;

an annular thrust ring having an inner conical surface loosely disposed in said circular recess, said annular thrust ring adapted to abut said radially-inwardly-extending shoulder of said driving clutch member when displaced in a first axial direction;

a plurality of centrifugal flyweight members annularly arranged within said circular recess, said flyweight members each having an inclined surface abutting said conical surface of said thrust ring operative to displace said thrust ring in a first axial direction in response to centrifugal force;

a plurality of support pins, one for each flyweight member connected to said driving clutch member and extending radially inward within said circular recess; and

each of said flyweight members having a radially-extending hole formed therein, connecting said weight members to respective support pins to prevent axial and permit radial movement of said flyweight members.

2. Engine starter gearing as claimed in claim **1** wherein said radially-extending holes formed in said flyweight members are formed at the approximate center of gravity of said weight members.

3. Engine starter gearing as claimed in claim **1** wherein said resilient means and said thrust ring apply opposed forces to said driving clutch member.

4. Engine starter gearing comprising:

a power shaft;

a sleeve slidably, but non-rotatably, secured to said power shaft, said sleeve having external helical splines formed on one extremity thereof;

a pinion gear slidably-journalled for axial movement relative to the power shaft adapted for movement into and out of engagement with a gear of the engine to be started;

an annular driven clutch member secured to said pinion gear for movement therewith and forming an annular recess radially inwardly of said driven clutch member;

a driving clutch member slidably mounted at one end on said helical splines of said sleeve;

said driving and driven clutch members having complementary mutually-engageable dentil teeth for transmitting torque therebetween;

a barrel housing having an open end, slidably supported on said sleeve and spatially encompassing said clutch members;

means within the housing adjacent the open end thereof adapted for engagement with the driven clutch member for confining the clutch members within the housing;

resilient means within said housing abutting said driving clutch member and biasing said clutch members into an engaged position wherein said driven clutch member engages said abutment means and said driving clutch member has an end extending off said sleeve member and adjacent said annular recess;

an annular thrust ring having an inner inclined surface loosely disposed in said circular recess and abutting the end of said driving clutch member extending off said sleeve member;

a plurality of arcuate centrifugal weight members annularly arranged within said annular recess, said weight members each having an inclined surface abutting said inclined surface of said thrust ring operative to displace said thrust ring and said driving

clutch member axially in response to centrifugal, thereby separating the dentil teeth of said clutch members at a predetermined rotational speed; and a plurality of radial support pins connected to said driving clutch member, one for each respective weight member to support said weight members while permitting radial movement thereof in response to centrifugal forces.

5. Engine starter gearing as claimed in claim 4, including stop means movable with said pinion gear and said

driven clutch member to provide a radially inward abutment stop for said weight members.

References Cited by the Examiner

UNITED STATES PATENTS

2,554,445 5/1951 Miller ..... 74—6

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