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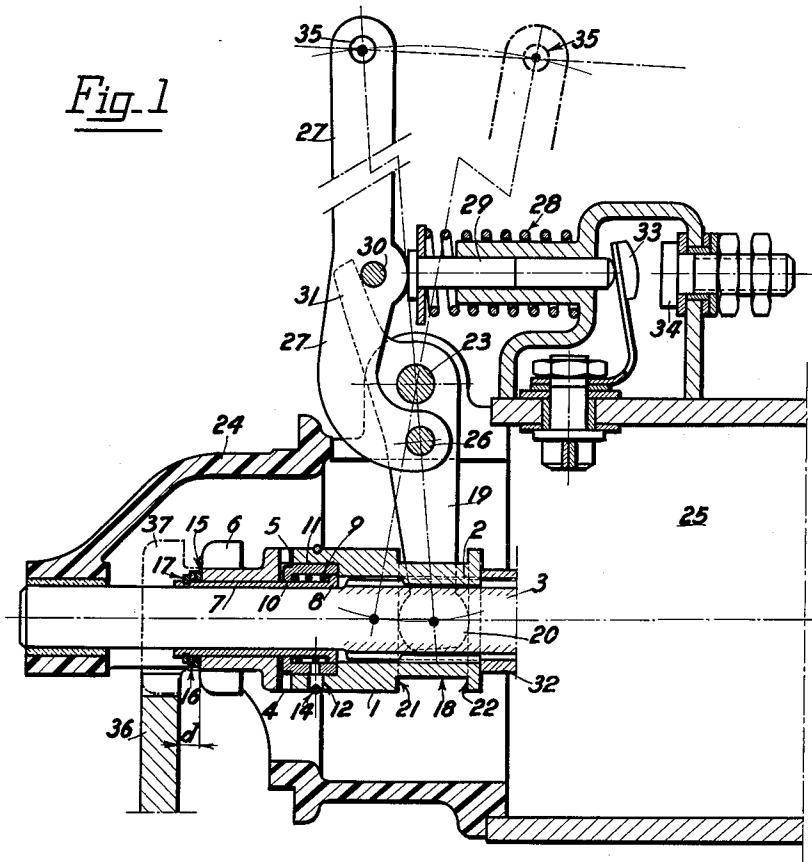
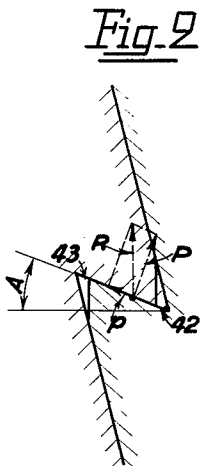
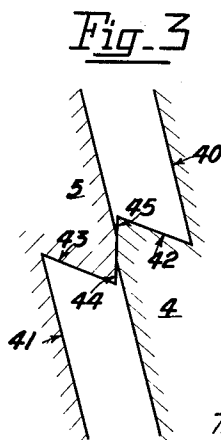
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3,089,344

STARTER FOR INTERNAL COMBUSTION ENGINES

Filed July 12, 1960

2 Sheets-Sheet 1



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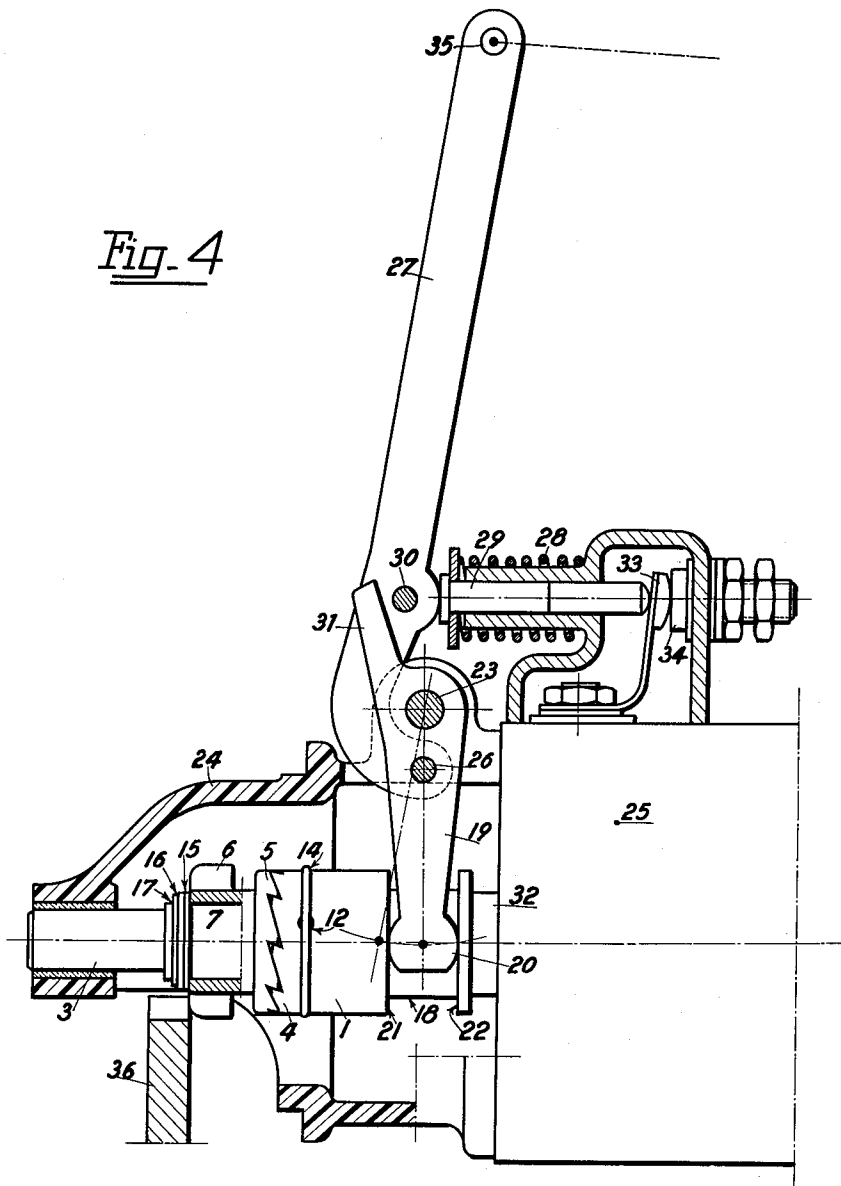
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STARTER FOR INTERNAL COMBUSTION ENGINES

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2 Sheets-Sheet 2

Fig. 4



1

3,089,344 STARTER FOR INTERNAL COMBUSTION ENGINES

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The present invention relates to internal combustion engine starters and comprises a sliding gear movable into engagement with the crown gear of the engine to be started, and a drive sleeve with toothed clutching means for imparting sliding and rotary movement to said gear.

The objects of this invention are to provide a starter of simple and inexpensive construction with a minimum number of parts, and which will be efficient and dependable in its operation. For attaining these objects, the clutching teeth between the sliding gear and the drive sleeve are so designed that the gear and the sleeve will be axially self-balancing and will operate with a minimum of axial reaction on the drive shaft or on other parts of the starter.

In an advantageous embodiment of such a starter, a spring under moderate but sufficient stress biases the sliding gear and the drive sleeve axially towards each other by exerting its longitudinal force, on the one hand, on the drive sleeve and, on the other hand, on a collar which is coaxial with and rotationally independent of the gear, the collar being however connected to the gear in the longitudinal direction so as to push the gear toward the drive sleeve, thereby ensuring the correct interengagement of the self-gripping teeth on the ends of the sleeve and gear. Preferably said collar also serves to mount the gear on the starter shaft and is slidable along the latter, there being another collar which is fixed in the central bore of the drive sleeve and slidably mounted on the first-mentioned collar so as to form a chamber in which is disposed the aforesaid spring.

It will be observed that the number of main elements of the starter of the invention is reduced to two, namely the drive sleeve and the gear, which are maintained together by two small sleeve members with an interposed spring. This assembly is referred to as the starter unit and constitutes an independent unit which is mounted as such on the starter motor shaft.

FIG. 1 is a longitudinal sectional view of the starter and its control mounted on a starter unit;

FIGS. 2 and 3 show the characteristic shape of the self-gripping teeth constituting the unidirectional clutching means of the starter; and

FIG. 4 is a view similar to FIG. 1 showing the position of the compound control lever of the starter when the teeth of the gear abut against the teeth of the crown gear.

In the embodiment shown in FIG. 1, the drive sleeve 1 is provided with internal splines 2 which are either straight or helical, in which latter case their slope relative to the axis is in the neighbourhood of the angle of friction. The sleeve 1 is slidably mounted on the shaft 3 of the starter unit which is provided with external splines cooperating with the internal splines 2.

Machined on the forward end of the drive sleeve 1 are self-gripping teeth 4 of characteristic shape referred to hereinafter. The teeth 4 are capable of interlocking with like self-gripping teeth 5 on the rear end of the gear 6 which gear is slidably and rotatably mounted on a collar 7. The collar 7 has a flange 8 against which a spring 9 bears. The spring 9 also bears against an inner flange 10 of a sleeve 11 centered in the drive sleeve 1. The sleeve 11 is rigidly attached to the drive sleeve 1 by means of one or more pins 12 which pins are held in position by a

2

ring 14. The sleeve 11 may also be attached to the drive sleeve by means of rivets (not shown) or in any other suitable manner.

Centered but removably mounted on the forward end of the collar 7 are two washers 15 and 16 maintained in position by a ring 17.

Provided on the drive sleeve 1 is a recess 18 in which engages, between shoulders 21, 22, the circular ends 20 of a fork 19. The fork is pivotably mounted on a pin 23 on the forward bearing 24 of the starter housing.

Pivotably mounted on the fork 19 at 26 is a lever 27 which is adapted to compress the spring 28 through the medium of a pushrod 29. The lever 27 is maintained in its position of departure by the thrust of the spring 28 which biases the pivot 30 mounted on the lever 27 against an extension 31 of the fork 19. The lever 27 and the fork 19 then constitute a compound lever which can act as a single lever so as to return the starter to the position of rest against an abutment 32 provided on the shaft 3. The pushrod 29 ensures contact between the contacts 33 and 34 through which current is supplied to the starter motor 25.

A cable, rod or the like is attached to the end 35 of the lever 27 for shifting the starter, which is manually operated in the presently-described embodiment.

At rest, the gear 6 is spaced a suitable distance d from the ring gear 36.

The self-gripping teeth 4 and 5 have a special shape which constitutes a very important feature of the starter of the invention.

FIGS. 2 and 3 show this shape which is defined by:

The faces 40 and 41 which are preferably orthogonal or substantially orthogonal helicoids the tangents of which make the largest possible angle with the axis of the starter.

The faces 42 and 43 which are advantageously orthogonal or substantially orthogonal helicoids the tangents of which have the same direction as the tangent of the faces 40 and 41 and make an angle effectively comprised between the angle of friction of the materials in contact, as minimum, and 25° .

The flat portions 44 and 45 disposed in the same plane perpendicular to the axis of the starter and of such length as to increase the volume of material of the self-gripping teeth thereby minimizing their brittleness after hardening and tempering.

The self-gripping teeth 4 and 5 are ordinarily held in contact with sufficient but moderate pressure by the spring 9 which, in bearing against the flange 10 of the sleeve 11, urges the flange 8 of the collar 7 rearwardly. The collar 7, through the medium of the abutment constituted by the washers 15 and 16, forces the gear 6 against the drive sleeve 1 thereby ensuring interengagement of the self-gripping teeth 4 and 5.

The starter of the invention operates in the following manner:

When the teeth of the gear 6 and the ring gear 36 are in a position for meshing, as shown in FIG. 1, and the lever 27 is displaced by pulling thereon at 35, the lever urges the push rod 29 to the right in opposition to the action of the spring 28 and pivots the fork 19 through the medium of the pin 26, which brings the starter and its gear 6 to the position 37 (shown in dot-dash line) in which latter position the gear 6 meshes with the gear 36; at the same time, the pushrod 29 causes the contacts 33 and 34 to close. Currents is then supplied to the starter motor 25 which causes the same to rotate. Rotation of the motor will cause the shaft 3 to rotate and, in turn, rotate the starter unit. The ring gear 36 of the engine will thus be rotated. Upon the release of the lever 27 the spring 28 will return the lever 27 and the

associated lever 19 and the starter unit to the disengaged position shown in FIG. 1. Contacts 33 and 34 will open causing the motor 25 to discontinue rotation.

When the teeth of the gear 6 and the gear 36 are in a position so as to abut each other if engaged, as shown in FIG. 4, pulling of the lever 27 at 35 will cause the pushrod 29 to be urged to the right (as viewed in FIG. 1) in opposition to the action of the spring 28. The fork 19 will be pivoted about the pin 23 through the medium of the pin 26. This action will cause the starter unit to be displaced until the teeth of the gear 6 abut the teeth of the gear 36. Movement of the starter unit and the fork 19 will stop and will resist the force exerted by the lever 27 which, in continuing to move, causes its pin 30 to leave the extension 31 of the fork 19 and further causes, through the medium of the push rod 29, the contacts 33 and 34 to come into engagement. Completion of an electrical circuit through contacts 33 and 34 results in rotation of the starter motor 25 and consequently of the gear 6 which is immediately in position for meshing with the gear 36. As soon as this meshing is possible, the fork 19, which is biased at 26 by the lever 27 upon which the spring 28 exerts its force, urges the starter unit to the position 37 (shown in FIG. 1), the fork being assisted if necessary by an additional traction on the end 35. In this positioning movement the extension 31 of the fork returns to a position of abutment against the pivot 30 of the lever 27, as shown in FIG. 1.

The starter unit being in mesh, the starter motor 25 will cause the ring gear 36 to be rotated. Upon the release of the lever 27, the spring 28 returns the starter unit to its initial position of departure shown in FIG. 1.

During starting, the driving force is transmitted by the internal splines 2 and the self-gripping teeth 4 and 5 to the gear 6 which drives the gear 36 connected to the engine.

As a result of this driving force, the teeth 4 interlock with the teeth 5 and, owing to their configuration, the tangential driving force to which is opposed the resistant force of the gear 36, creates a reaction force R which is perpendicular to the axis of the starter and is composed of a force P perpendicular to the contacting helicoids 42 and 43 and a force p parallel with these helicoids 42 and 43.

The force p tends to cause the helicoids 42 and 43 to slide along each other and to block the gear 6 against the drive sleeve 1 so that these elements form a block without reaction on the shaft of the starter motor or on any other element of the starter. Transmission of the driving torque occurs with safety and without risk of deterioration of the self-gripping teeth which remain always strongly interlocked during transmission of the torque.

It is sufficient that the angle A be greater than the angle of friction of the materials in contact for the sliding force p to be positive in the blocking reaction. To ensure that this is always realized, it is advantageous that the angle A be between 10° and 25° in most cases, and that the teeth be relatively deep so as to ensure that the bearing faces 42 and 43 will be wide enough to be effective.

As soon as the engine has started, the gear 36 becomes the driving element and drives the gear 6 which rotates at a speed higher than that of the drive sleeve 1, so that the teeth 4 and 5 become disengaged and periodically compress the spring 9. The gear 6 then rotates freely on the collar 7 which slides along the shaft 3 at the rate of disengagement of the teeth 4 and 5. The extent of the return of the teeth 4 and 5 into each other decreases with increase of relative speed between the gear 6 and the drive sleeve 1, depending on the friction between the collar 7 and the shaft 3 and its momentum which is added to that of the gear 6. In this way there is obtained, as this relative speed between the gear 6 and the sleeve 1 increases, a decrease in the noise of the freewheel opera-

tion and a notable decrease in the wear of the self-gripping teeth 4 and 5.

Depending on the shapes and dimensions of the self-gripping teeth, these together with the sleeve 1 could be driven by either straight flutes 2 which are parallel to the axis of the starter, or by helical flutes having a slope angle in the neighborhood of the angle of friction and a chirality or direction of twist opposite to that of the helicoids constituting the teeth.

Further, to facilitate the engagement and the disengagement of the gear 6 and the gear 36, the teeth can be machined helically but with a slight slope and in such manner that the tangent to the cutting helix makes an angle with the axis of the starter which is in the neighborhood of the angle of friction. Moreover, the direction of the cutting helixes is opposite to that of the helixes defining the self-gripping teeth and is left-hand for a starter rotating in a counterclockwise direction and right-hand for a starter rotating in a clockwise direction.

The fork 19 and the lever 27 form an assembly which, owing to the extension 31 and the abutment 30, permits controlling of the starter in all cases with a single spring such as 28 which returns the starter to the position of rest, and upon retraction of the end 35 of the lever 37 provides the required elasticity when the teeth of the gear 6 and of the crown gear 36 butt against each other, so that only a limited force can be exerted on the end 35 of the lever 27.

It is to be understood that although only one embodiment of this invention has been illustrated and described, various changes may be made in the design and arrangement of the parts illustrated without departing from the spirit and scope of the invention as now recited in the claims.

What I claim is:

1. In a self-contained an axially self-balanced starter for engines, a starting motor having an extended drive shaft, a drive sleeve slidably keyed on the drive shaft, clutch teeth on the drive sleeve, a flanged collar slidably mounted on the drive shaft, means for resiliently connecting the drive sleeve with the collar, a gear slidably connected to the collar, and clutch teeth on the gear adapted to be engaged by the clutch teeth on the drive sleeve to be driven thereby, each of said clutch teeth presenting a sliding face and a driving face, both of which faces are helicoidal in shape and of the same chirality but of different pitch so as to form a self-tightening ratchet.

2. The starter of claim 1, in which the clutch teeth have truncated terminals presenting faces substantially perpendicular to the starter axis.

3. In a starter for engines, a starting motor having an extended drive shaft, a drive sleeve slidably keyed on the drive shaft, clutch teeth on the drive sleeve, a flanged collar slidably mounted on the drive shaft, means for resiliently connecting the drive sleeve with the collar, a gear slidably mounted on the collar, and clutch teeth on the gear adapted to be engaged by the clutch teeth on the drive sleeve to be driven thereby, each of said clutch teeth presenting a sliding face and a driving face, both of which faces are helicoidal in shape and of the same chirality but of different pitch so as to form a self-tightening ratchet.

4. The starter of claim 3 in which the clutch teeth have truncated terminals presenting faces substantially perpendicular to the starter axis.

5. The starter of claim 3 in which the means for resiliently connecting the drive sleeve with the collar includes an internally flanged tube carried by the drive sleeve and overlapping an externally flanged end of the collar so as to form a cylindrical chamber between the flanges, and a coiled spring in this chamber bearing against the two flanges.

6. In a starter for engines, a starting motor having an extended drive shaft, a drive sleeve slidably keyed on the drive shaft, clutch teeth on the drive sleeve, a collar slid-

5

able on the drive shaft, a gear slidably connected to the collar, clutch teeth on the gear adapted to be engaged by the clutch teeth on the drive sleeve to be driven thereby, means for resiliently connecting the drive sleeve and the collar, a pivoted fork one end of which engages the drive sleeve to slide the latter along the drive shaft, a manually actuated lever pivotally mounted on the fork on an axis spaced from the axis of the fork pivot and adapted to engage or disengage another portion of the fork to swing or release the latter, and a spring-actuated member pushing against the lever in a direction to cause the lever to engage the fork.

7. The starter of claim 6 in which the spring-actuated member consists of a slidable push-rod.

8. The starter of claim 6 in combination with an electric switch for controlling the operation of the starting motor, said switch being closed by manual retraction of the lever.

6

9. The starter of claim 8 in which the spring-actuated member comprises a slidably mounted push-rod, one end of which bears against the lever and the other end of which closes the switch.

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