United States Patent

[11] 3,561,415

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[33] **Great Britain**
[31] **35081/68**

[54] INTERNAL COMBUSTION ENGINE STARTER MECHANISM

4 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **123/185**
[51] **Int. Cl.** **F02n 1/100**
[50] **Field of Search** 123/179K, 185CI, 185C, 185A, 185B, 185B-1, 185B-2, 55

[56] **References Cited**

UNITED STATES PATENTS

2,895,466	7/1959	Mall et al.	123/185
3,329,134	7/1967	Llewellyn	123/55

FOREIGN PATENTS

8,365	6/1915	Great Britain	123/185

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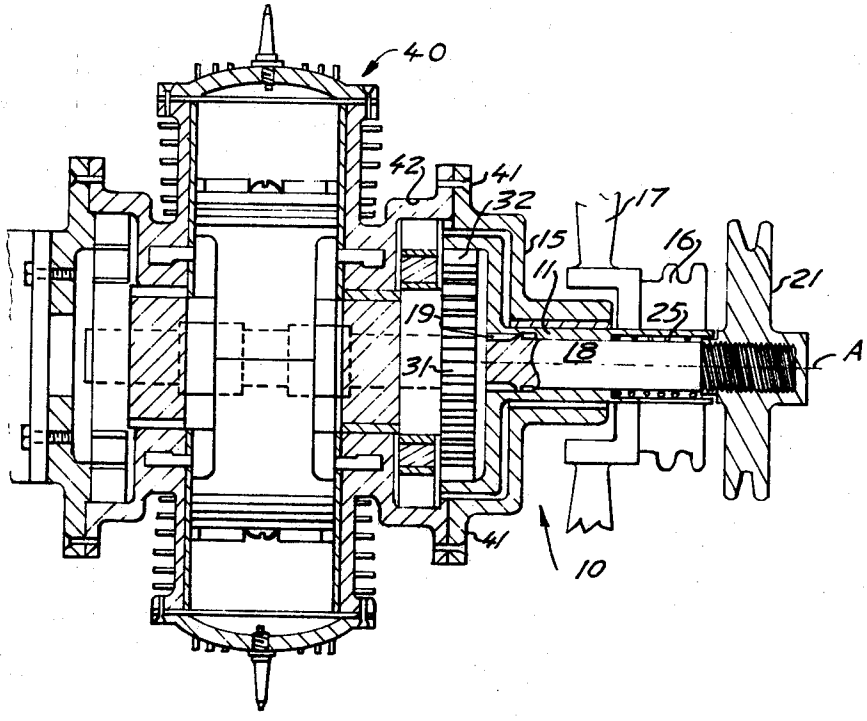
ABSTRACT: Starter mechanism for a high speed engine having epicyclic output speed reduction gearing rendering cranking difficult. A starter pinion shaft with a pinion at an inner end and a starter pulley at an outer end, the shaft slidable inwards and outwards for engagement and disengagement of the pinion with a ring gear applying multiplied torque to the crankshaft through a part of the reduction gearing. Beveled teeth on nondriving faces of the teeth of the pinion provide automatic disengagement as the engine starts.



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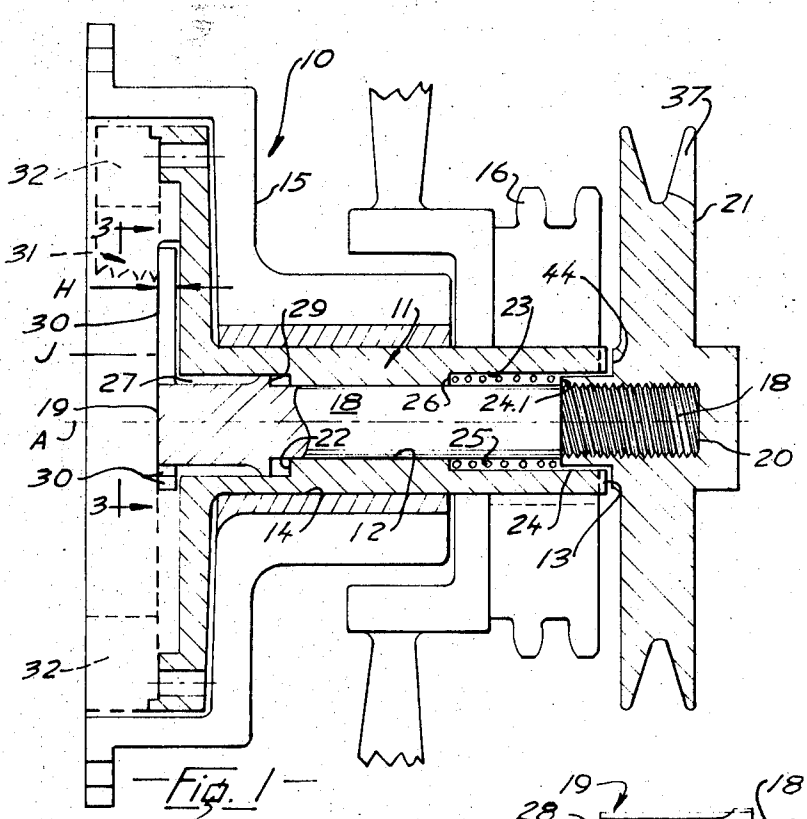

Fig. 1

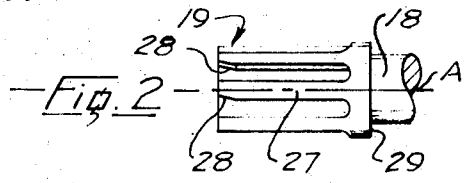

Fig. 2

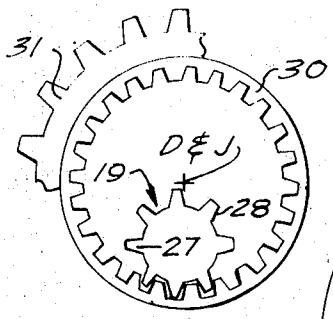

Fig. 3

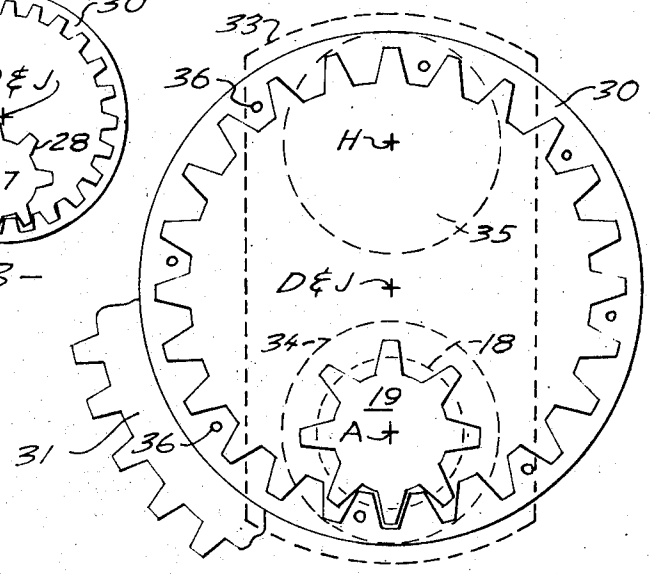

Fig. 4

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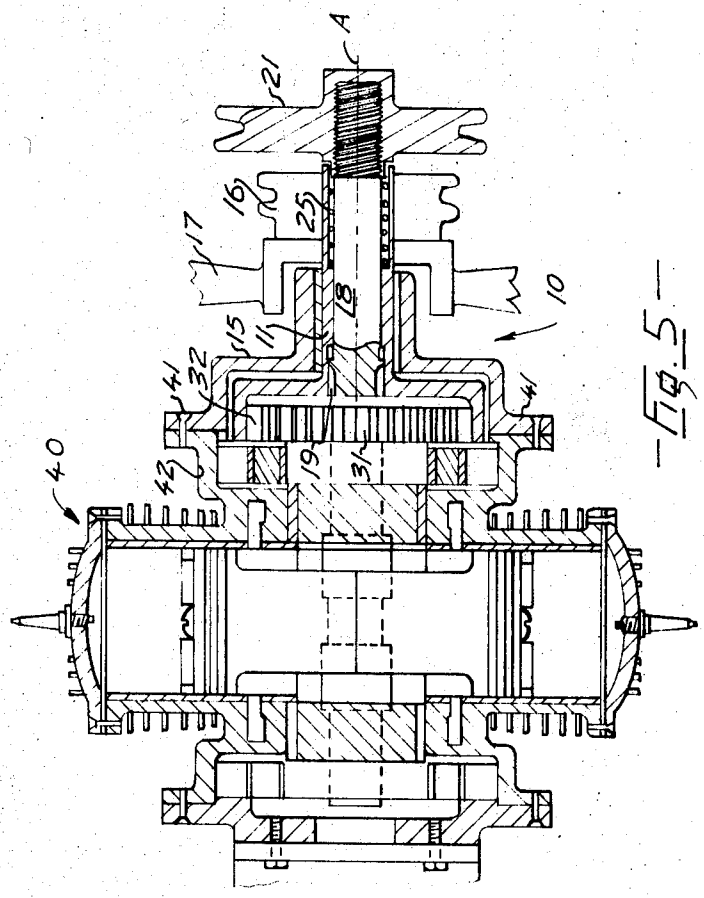

FIG. 5

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INTERNAL COMBUSTION ENGINE STARTER MECHANISM

BACKGROUND OF INVENTION

Small motor rope starter mechanisms usually include an overrunning clutch or ratchet device so that, when the engine starts, the starter disengages. For larger engines a starter motor is commonly provided, together with a disengaging mechanism. Perhaps the best known and most successful is the Bendix starter disengagement mechanism.

U.S. Pat. No. 3,329,134, for an INTERNAL COMBUSTION ENGINE issued on 4 Jul. 1967 to Leopold W. Llewellyn the inventor herein. This patent discloses improvements in piston-type internal combustion engines, particularly of small size. This is a high speed engine characterized by a relatively small number of moving parts and avoids the use of connecting rods, teaching an unusual crank shaft motion such that power takeoff is effected by means of an epicyclic train providing a speed reduction ratio between the crankshaft and a power output shaft so that the latter is driven at reduced speed.

The present invention relates to a cranking mechanism particularly but not exclusively for use with this engine in which, if cranking is attempted through the epicyclic power takeoff mechanism cranking torque required is multiplied by the epicyclic train ratio.

SUMMARY OF THE INVENTION

The cranking torque can be reduced by using a pinion concentric with a hollow power output shaft, thus utilizing a gearing advantage and applying increased torque to the crankshaft. This structure permits use of a small light starter motor, or other starting means, and simplified starter gearing.

In the present invention a starter pinion, teeth of which are beveled on a nondriving side, is provided and this pinion meshes with a driven ring gear for starting purposes. When the engine starts, the driven ring gear becomes a driving gear which initially tends to drive the starter pinion. Reaction at the bevel now acts to urge the starter pinion axially out of engagement, a helical compression spring being provided to assist disengagement.

DESCRIPTION OF DRAWINGS

FIG. 1 is a longitudinal section of starter mechanism according to the invention, with some parts not shown in section.

FIG. 2 is a fragmented detail of a starter pinion showing a bevel of a tooth.

FIG. 3 shows the starter pinion and a ring gear, as seen from 3–3 FIG. 1.

FIG. 4 is a view from 3–3 of FIG. 1 at enlarged scale, additionally a crankshaft web is shown in broken outline.

FIG. 5 shows the starter assembled to an internal combustion engine of the U.S. patent, the engine and starter being generally in section.

PREFERRED EMBODIMENT

A detail description following, related to drawings, gives exemplification of preferred embodiment of the invention which, however, is capable of expression in structure other than that particularly described and illustrated. The description is of the starter as applied to an engine of U.S. Pat. No. 3,329,134.

DESCRIPTION OF FIGS. 1 AND 2 WITH REFERENCE TO FIG. 5

As disclosed in the U.S. patent aforesaid, axes of power cylinders and charge cylinders intersect at right angles, the intersection being on a main crankcase axis or centerline of the engine shown in FIG. 5.

In FIG. 1, a starter mechanism is designated generally 10. A hollow power output shaft 11 having a bore 12 and an outer end 13 is concentric with the axis A, the shaft being journaled

in an integral sleeve bearing 14 mounted in a housing 15. Power is taken off the engine by a sprocket 16 secured to the shaft 11. An integral flywheel and cooling fan 17 is also secured to the shaft 11. A starter pinion shaft 18 is concentrically journaled within the shaft 11, the pinion shaft having an integral starter pinion 19 at one end, and at an opposite end 20 a starter drive means, namely a pulley 21, is secured the pulley being adapted for rope starting; or for connecting to a starter motor, not shown—in which latter alternative V-belt drive is provided. Alternatively a pinion, not shown, can be substituted for the pulley with obvious chain or gear drive.

The bore 12 is counterbored at an inner end to accept the starter pinion 19, the counterbore terminating at a shoulder 22. An end of the bore 12 remote from the shoulder 22 has an outer counterbore 23 to accept a sleeve 24 of the starter pulley, the sleeve having an inner end 24.1. A coil compression spring 25, an inner end of which bears against a shoulder 26 formed by the counterbore 23, extends within the bore from the said shoulder to the sleeve inner end 24.1.

The starter pinion 19 has involute teeth 27, outer ends of the teeth being beveled as seen at 28 FIG. 2. An inner shoulder 29, as shown, is defined by a change in diameter of the starter pinion shaft which is slidable. Relevant dimensions are such that, when the pulley 21 is pushed inwards of the hollow shaft 11, there is, as seen in FIG. 1, an axial separation of the shaft shoulder 29 from the counterbore shoulder 22. The spring 25 is of such length that, in a normal or disengaged position, the starter pulley 21 is urged away from the sprocket 16, thus urging the shoulder 29 against the shoulder 22. In the position shown in FIG. 1, with axial spacing between the shoulders the starter pinion is in meshing engagement with a starter ring gear 30 having internal teeth—which engagement is best seen in FIG. 3. As is later explained, the ring gear 30 is secured to a gear of an epicyclic output train of the engine so that rotation of the ring gear turns the engine over.

The starter pinion involute tooth bevels 28 are formed on nondriving faces of the teeth, as shown in FIG. 2. The bevels are at an angle of about 45° to the axis A, which angle is not critical within plus or minus about 5°. The bevels tend to urge the starter pinion out of engagement with the ring gear 30 when the engine has started and attained such speed that the ring gear is being driven by the engine. Thus, when the engine starts and runs, the bevels and the spring both urge the starter pinion out of engagement with the ring gear 30. This closes the axial separation F, withdrawing the starter pinion 19 from meshing engagement with the ring gear 30 and placing it within the counterbore of the power shaft 11 where it is held in the disengaged position by the spring with the shoulders 22 and 29 in contact.

DESCRIPTION OF FIGS. 3 AND 4 AND FURTHER REFERENCE TO FIGS. 1 AND 5

A takeoff pinion 31 of the engine is shown in fragmented broken outline in FIG. 1, and is shown fragmented in FIG. 3. The starter ring gear 30 is mounted concentric and integral with the pinion 31, and the pinion 31 meshes with a ring gear 32 secured to the power shaft 11; the ring gear 32 being a part of the epicyclic train of the engine, as is the pinion 31. As disclosed in the said U.S. patent, the ring gear 32 takes the power off the crankshaft of the engine through the pinion 31, which is mounted on an extension of the crankshaft. The takeoff pinion 31 is a part of the epicyclic reduction train of the engine. An axial centerline of the integral gears 31 and 30 is designated J in FIGS. 3 and 4, and coincides with a centerline of the crankshaft designated D which, as described in the U.S. patent, extends through a midpoint of a crankshaft web 33, as seen in FIG. 4, where the crankshaft extension is designated 34 and shown in broken outline. A crankpin 35 has a centerline designated H in FIG. 4, H and A being equidistant from D. The takeoff pinion of the engine is in mesh with the flywheel ring gear 32 on one side of the engine centerline A as seen in FIG. 1, whilst the starter pinion 19, (which is coaxial with the

centerline A), is, in starting, simultaneously in mesh with the starter ring gear **30** on a diametrically opposite side of the engine centerline.

Referring particularly to FIG. **4**, the ring gear **30** is secured by bolt means **36** (shown only in FIG. **4**) to the engine takeoff pinion **31** so that these two gears are integral as aforesaid.

DESCRIPTION OF FIG. 5

In FIG. **5** the starter **10** is shown assembled to an internal combustion engine **40** according to the U.S. Pat. No. 3,329,134. The housing **15** of the starter is bolted at **41** to a housing **42** of the engine **40** as shown. The epicyclic gear **31** is shown, the starter ring gear **30**—not visable in FIG. **5**—being secured thereto as explained, and the epicyclic ring gear **32** is shown in engagement with the gear **31**. A part of the starter pinion is seen, the pulley **21** being shown engaged as in FIG. **1**.

It is seen that the instant starter structure in combination with a part of the epicyclic reduction train of the U.S. patent effects torque multiplication.

OPERATION

The starter pulley **21** FIG. **1** has a flange slot **37** for a knot of rope, not shown. In operation, the starter pulley **21** is pushed in until an inner boss **44** thereof bears against the outer end **13** of the power shaft **11**. In this position, the spring **25** is compressed and the starter pinion **19** engages the starter ring gear **30**. When the rope is pulled, friction between driving faces of the teeth is sufficient to hold the pinion in engagement against disengaging face of the spring. Pulling the rope applies torque to the shaft **18**, the torque being tension of the rope acting through an arm which is the radius of the pulley **21**. It is seen from the FIG. **4** that this torque is multiplied by the ratio of the pinion **19** and ring gear **30** diameters. The multiplied torque is applied about the axes D and J, so turning over the engine to start it.

I claim:

1. Starter mechanism for an internal combustion engine having a crankshaft and speed reduction means driving a hollow power output shaft (**11**) at a speed less than that of the crankshaft; in combination with the speed reduction means a starter mechanism characterized by:

a. a starter pinion shaft (**18**) concentrically journaled in the hollow output shaft and slidable axially thereof, the starter shaft having a starter pinion (**19**) at one end and a starter drive means (**21**) at an opposite end; the pinion having teeth (**27**) with bevels (**28**) formed on nondriving faces thereof;

b. a starter ring gear (**30**) having internal teeth adapted for meshing engagement with the teeth of the pinion, and being mounted on and concentric with a takeoff pinion (**31**) of the speed reduction means to rotate therewith; and

c. a compression spring (**25**) urging the starter pinion shaft to slide axially of the hollow shaft in a direction to move the starter pinion out of engagement with the ring gear; constructed and arranged for the starter drive means to be slidable axially inwards against the spring for meshing engagement of the starter pinion and the starter ring gear so that rotation of the starter drive means rotates the crankshaft, with meshing engagement being maintained by force between driving faces of the teeth, and so that when the engine starts the ring gear momentarily drives the starter pinion, reactions of the ring gear teeth and the bevels of the starter pinion teeth then effecting disengagement.

2. Mechanism as defined in claim **1**, the starter drive means having an inner boss (**44**) which, when the drive means is pressed inwards, bears against an outer end (**13**) of the power shaft when the starter pinion and ring gear are in meshing engagement as aforesaid.

3. Mechanism as defined in claim **2**, an inner shoulder (**29**) defined by a change in diameter of the starter pinion shaft, and a counterbore at an inner end of the hollow output shaft defining a shoulder (**22**), the shoulders limiting outward slidable movement of the starter pinion shaft (**11**) and defining a position of disengagement of the starter pinion and ring gear, the counterbore being adapted to accept the starter pinion.

4. Mechanism as defined in claim **3**, the hollow power output shaft (**11**) having an outer counter (**23**) to accept a sleeve (**24**) of the starter drive means and defining a shoulder (**26**), with the spring (**25**) extending in compression between the two shoulders last aforesaid.