B. BROOKS & W. HOLT.

ELECTRIC STARTER FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED OCT. 26, 1914.

1,151,439.

Patented Aug. 24, 1915.

3 SHEETS—SHEET 1.

Fig. 1.

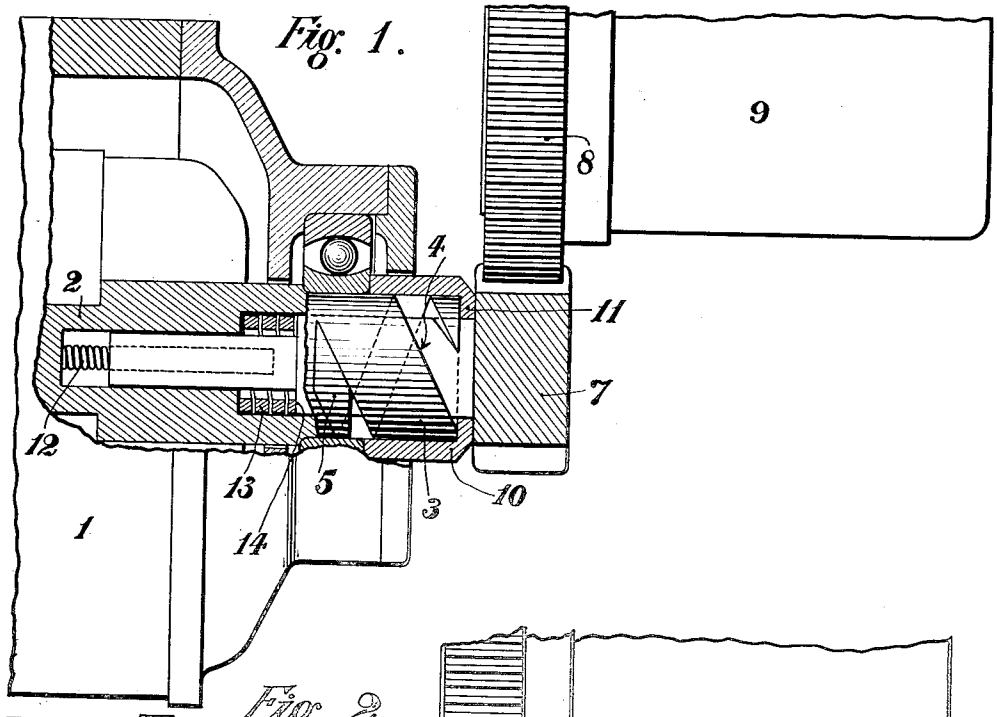
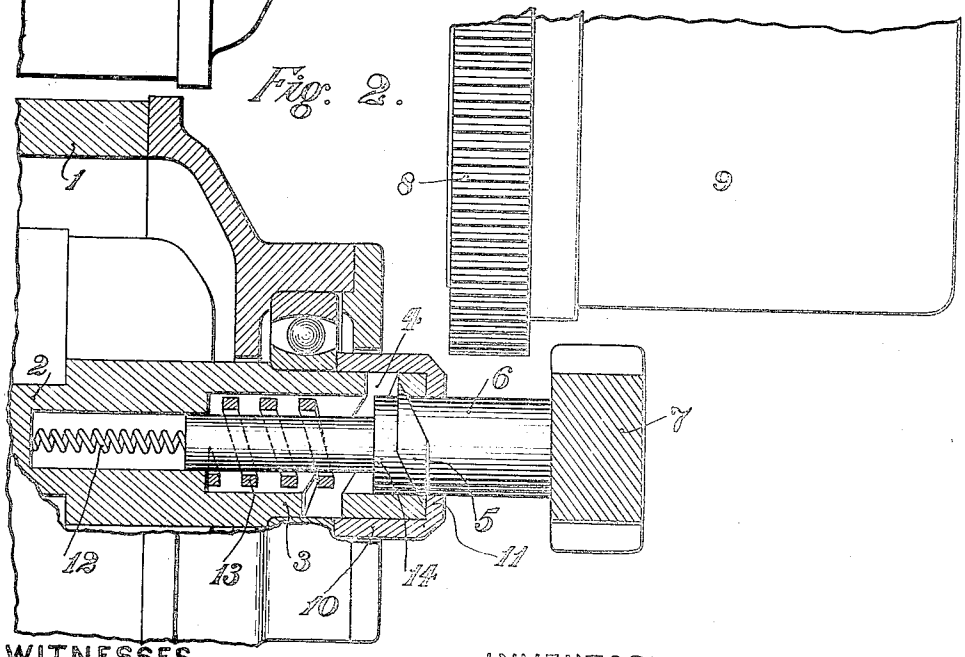


Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 3.

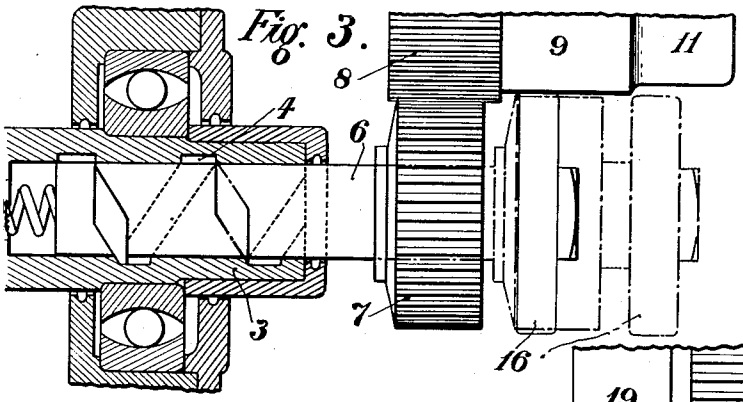


Fig. 5.

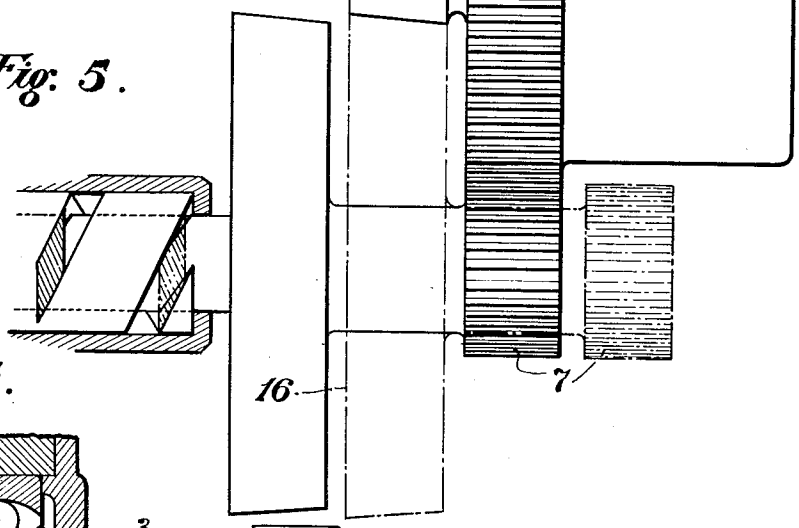
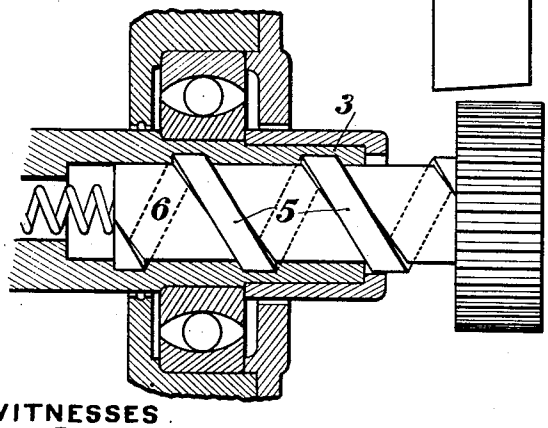


Fig. 4.



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3 SHEETS—SHEET 3.

Fig. 6.

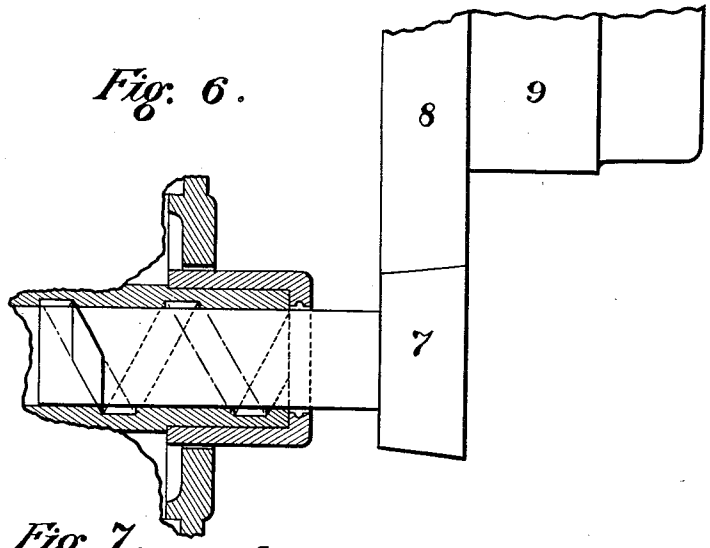


Fig. 7.

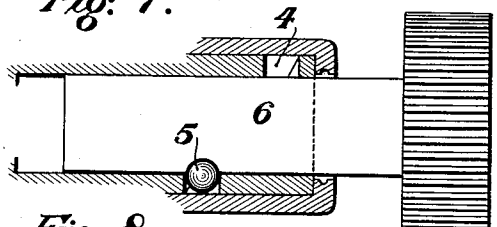
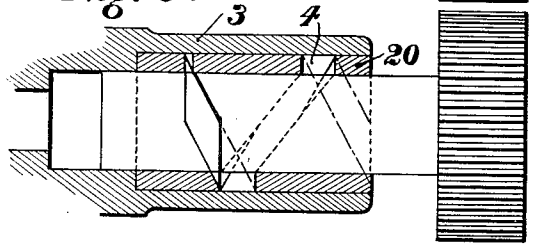


Fig. 8.



WITNESSES

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UNITED STATES PATENT OFFICE.

BOULTBEE BROOKS AND WILLIAM HOLT, OF BIRMINGHAM, ENGLAND.

ELECTRIC STARTER FOR INTERNAL-COMBUSTION ENGINES.

1,151,439. Specification of Letters Patent. Patented Aug. 24, 1915.

Application filed October 26, 1914. Serial No. 868,704.

To all whom it may concern:

Be it known that we, BOULTBEE BROOKS and WILLIAM HOLT, subjects of the King of Great Britain, residing at Criterion Works, Great Charles street, Birmingham, England, and 213 Slade Road, Erdington, Birmingham, England, respectively, have invented certain new and useful Improvements in Electric Starters for Internal-Combustion Engines, of which the following is a specification.

This invention relates to means for starting internal combustion engines, the said means being of that type comprising an electric or other auxiliary motor (having a powerful starting torque) adapted to be connected up with the engine by means of a shiftable gear-wheel or pinion which is connected with the driving shaft of said motor through the medium of a screw device comprising a projecting part or helical thread on one member engaging with a helical cooperating part provided in connection with the other member, so that when one of the said members of the screw device is directly driven by the motor the gear-wheel, owing to its inertia, lags behind the driving shaft and is thereby traversed axially and taken into gear with a suitable driven member connected with the engine shaft, while as soon as the engine runs under its own power the driven member over-runs the gear-wheel and causes the latter to be traversed axially in the opposite direction and thus to be automatically thrown out of gear.

The object of the present invention is to provide an improved and more efficient starter of the above type.

The present invention consists essentially in forming the motor-driven shaft with a hollow or tubular end, around the interior of which is formed a helical slot, groove, or screw-thread, which is adapted to be engaged by a stud or pin upon a spindle or boss carried by the movable gear wheel, or with a screw-thread formed around the said spindle or boss. And in order to maintain the pinion in its out-of-gear position and also assist the effect of the inertia of the said pinion, a friction disk may be provided which engages with the periphery of the driven part when the pinion is taken into gear, but which is moved out of engagement therewith when said pinion is taken out of gear.

Figure 1 of the accompanying drawings represents a section through one end of an electric starting motor having a shiftable gear-wheel or pinion constructed and arranged in accordance with this invention. This view shows the said pinion in gear with the engine fly-wheel. Fig. 2 is a sectional elevation showing the pinion in its out-of-gear position. Fig. 3 shows a modification in which a friction disk is provided in conjunction with the pinion for the purpose of maintaining the pinion in its out-of-gear position and assisting the inertia. This view shows, by full lines, the pinion in gear, and by dotted lines the position of said pinion when out of gear. Fig. 4 represents another modification. Fig. 5 shows a modified form of friction device which serves to convey the drive from the engine to the dynamo-electric machine when the latter is driven as a generator, and to reduce the gear ratio of the said drive. Figs. 6 to 8 illustrate further modifications.

Referring to Figs. 1 and 2, 1 is a series-wound electric motor whose shaft 2 is extended and formed with a hollow sleeve-like or tubular end 3 in which is formed a helical slot 4. This slot is adapted to be engaged by a stud or key 5 upon an elongated boss or stem 6 carried by a toothed gear-wheel 7, the said gear-wheel being adapted to be brought into engagement with a ring of teeth 8 provided around the periphery of the engine fly-wheel 9. When the engine is not running the gear-wheel 7 is out of engagement with the teeth upon the fly-wheel, as in Fig. 2 but when the current is switched on to the electric motor, the latter, being under no load, gains speed very rapidly; the toothed gear wheel 7, however, by reason of its inertia, tends to lag behind the motor shaft. Owing to the stud 5 engaging within the helical slot 4, a longitudinal movement is imparted to the said gear-wheel, and it is drawn inward into mesh with the teeth upon the fly wheel, as in Fig. 1. The gear-wheel and motor shaft are thus locked together and the drive is transmitted directly to the engine until the latter runs under its own power. As soon as this happens the gear-wheel 7 becomes the driven member and owing to the engine over-running the electric motor it receives a torque in the opposite direction, so that it is caused to travel axially away from the teeth upon the fly-wheel, so that the teeth are disen-

gaged and the electric motor disconnected from the engine (Fig. 2).

In order to prevent the stud 5 upon the spindle of the gear-wheel from being completely disengaged from the helical slot, there is fitted over the end of the shaft 3 a cap or cover 10 having an annular inwardly extending flange 11, against which the stud 5 abuts when the gear-wheel reaches the end of its outward travel.

To keep the pinion normally in its out-of-gear position, so that the stud 5 bears against the stop, a coiled spring 12 is fitted within a suitable housing in the end of the gear-wheel boss 6 so as to project therefrom and engage with the inner end of the tubular portion of the shaft 2. A further, but stronger spring 13 is employed surrounding the end of the gear-wheel boss 6 and arranged so that its one end abuts against the shoulder 14 of the latter, when the boss moves inward, while its other end abuts against a shoulder 15 of the tubular part 3 of the motor-shaft, the said spring 13 thus serving as a buffer when the gear-wheel is moved into engagement with the teeth upon the fly-wheel.

As shown in Fig. 3, instead of the tubular end 3 of the shaft being formed with a helical slot, as above described, it may be formed with an internal helical groove, or screw thread 4, while in another form instead of a stud or projection being provided upon the gear wheel spindle 6, the latter may be formed (as shown in Fig. 4) with an external screw-thread 5 engaging a helical groove inside the tubular part 3. Fig. 3 also shows the use of a friction disk 16 fixed upon the shaft 6 adjacent to the pinion 7 and of slightly larger diameter than the latter, so that when the pinion is in gear the disk engages with the periphery of the fly-wheel 9, as shown by full lines, but when said pinion is out of gear (shown by dotted lines) then the disk takes a position opposite to a reduced portion 11 of the fly-wheel, out of engagement with the latter. In this out-of-gear condition the distance of the friction disk from the edge of the larger portion of the fly-wheel is less than the distance between the pinion and the gear ring 8, so that when starting, the friction disk is engaged with the fly-wheel in advance of the pinion 7. The latter, being mounted upon the motor shaft 6, is moved axially when the electric motor is started (due to the inertia of the pinion and friction disk and the rapid acceleration of the motor) and the friction disk 16, coming into engagement with the larger diameter of the fly-wheel, offers a drag or resistance which insures the gear pinion 7 being completely shifted over into engagement with the gear ring 8, so that the drive is conveyed to the engine. When the latter runs under its own power and the fly-wheel overruns the motor, the action of the friction disk 16 is to assist to throw the pinion 7 out of gear, and to maintain it in this condition, as should (by vibration or otherwise) the pinion be moved toward the gear-ring, the friction disk will engage with the fly-wheel before the pinion can enter into gear, and thus said pinion will be again taken back to its extreme out-of-gear position.

In the modifications represented in Fig. 5 as used in connection with an electric starting motor adapted to be driven by the engine as a generator, the shaft or boss of the gear pinion 7 carries a friction wheel 16 of considerably larger diameter than the pinion, and when the latter has been thrown out of gear, as previously described, on the engine commencing to run under its own power, the said friction wheel is moved into gear with another friction wheel 19 carried by the fly-wheel 9 (as shown by dotted lines) so that the drive from the engine is transmitted through the friction wheels 19, 16, to the motor, which is thus driven as a dynamo. The gear ratio is by this means very considerably reduced when the dynamo-electric runs as a dynamo. The friction wheels may be slightly conical, as shown. The wheel 16 besides serving to convey the drive from the engine, also acts as a friction drag device for maintaining the toothed pinion in its out-of-gear position and for throwing it into gear when necessary.

If desired, in any of the herein described arrangements a friction drive may be employed for conveying the power from the electric motor to the engine at starting, instead of toothed wheels, as shown in Fig. 6, where 8 is a friction wheel on the fly-wheel 9, and 7 is a friction pinion on the shaft 6, adapted to be taken into engagement with the wheel 8. Also, instead of a stud on the extension 6 of the gear-wheel engaging the helical slot, a freely rotatable ball 5 (see Fig. 7) may be carried by said extension 6 so as to engage with the helical groove 4.

If desired the pinion 7 may be separately attached to the extension 6 instead of being solid therewith, while the spring 12 may be omitted if convenient. Also, as in Fig. 8, the helical slot or groove 4 may be cut in a separate piece or liner 20 which is inserted in or attached to the hollow shaft 3 of the motor.

Having fully described our said invention, what we desire to claim and secure by Letters Patent is:—

1. A starter for internal combustion engines comprising a motor, a driven member connected with the engine shaft, a shiftable gear wheel adapted to engage with said driven member, an axial extension carried by said gear wheel, a projection upon said

axial extension, and a shaft driven by the motor having a hollow end engaged by the axial extension of the gear wheel, and having a helical guide coöperating with the said projection to cause the gear wheel to be traversed axially when the motor is started and when the engine runs under its own power.

2. A starter for internal combustion engines comprising a starting motor, a driven member connected with the engine shaft, a shiftable gear wheel adapted to engage with said driven member, an axial extension carried by said gear wheel, a projection upon said axial extension, a shaft driven by the motor having a hollow end engaged by the axial extension of the gear wheel and having a helical guide coöperating with the said projection to cause the gear wheel to be traversed axially when the motor is started and when the engine runs under its own power, a coiled spring within the hollow end of the motor shaft for maintaining the gear wheel in its out-of-gear position, and a stop for limiting the outward movement of said gear wheel.

3. A starter for internal combustion engines comprising a starting motor, a driven member connected with the engine shaft, a shiftable gear wheel adapted to engage with said driven member, an axial extension carried by said gear wheel, a projection upon said axial extension, a shaft driven by the motor having a hollow end engaged by the axial extension of the gear wheel and having a helical guide coöperating with the said projection, and a cap fitted upon the hollow end of the shaft and having an internal flange forming a stop for engagement by the projection on the axial extension of the gear wheel.

4. A starter for internal combustion engines comprising a starting motor, a driven member connected with the engine shaft, a shiftable gear wheel adapted to engage with said driven member, an axial extension carried by said gear wheel, a projection upon said axial extension, a shaft driven by the motor having a hollow end engaged by the axial extension of the gear wheel and having a helical guide coöperating with the said projection, a shoulder upon the axial extension of the gear-wheel, an opposed abutment within the hollow end of the motor shaft, and a coiled buffer spring interposed between the said shoulders.

In testimony whereof we have hereunto set our hands in presence of two subscribing witnesses.

BOULTBEE BROOKS.
WILLIAM HOLT.

Witnesses:
HENRY NORTON SKERRETT,
WILLIAM STAIBES SKERRETT.