April 26, 1932. R. CHILTON 1,855,281

ENGINE STARTER

Filed Nov. 22, 1927

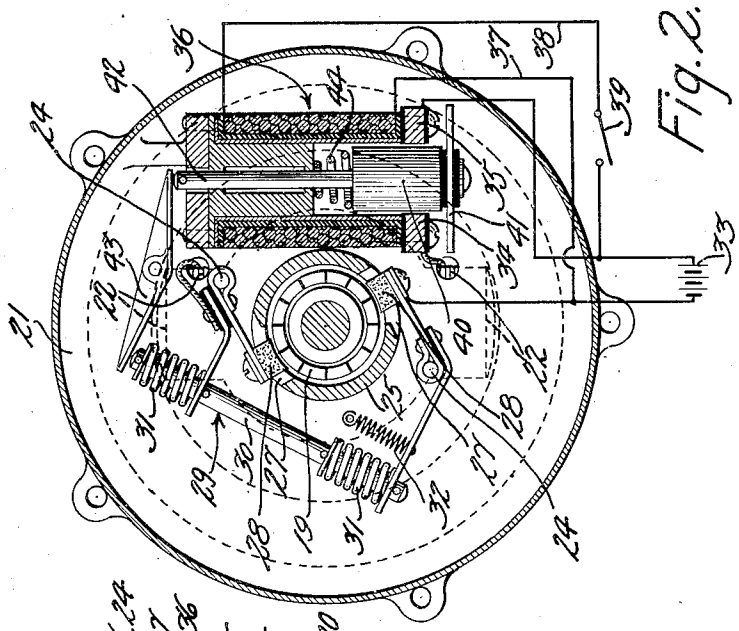


Fig. 2.

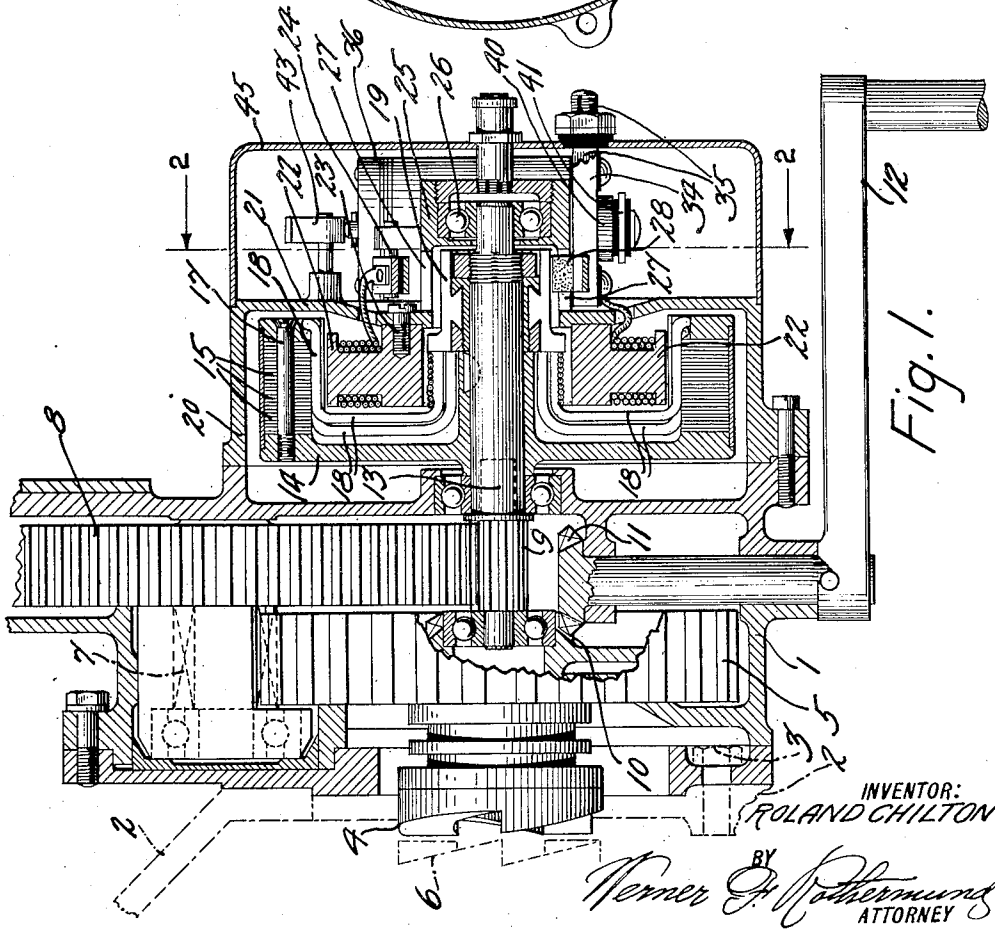


Fig. 1.

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UNITED STATES PATENT OFFICE

ROLAND CHILTON, OF KEYPORT, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO ECLIPSE MACHINE COMPANY, OF ELMIRA HEIGHTS, NEW YORK, A CORPORATION OF NEW YORK

ENGINE STARTER

Application filed November 22, 1927. Serial No. 235,101.

This invention relates to engine starters of the class wherein an inertia member is accelerated to high speed; the energy thus accumulated then being applied at a relatively high rate to the engine to be started. In such starters, the flywheel may be brought up to speed by either manual cranking or by an electric motor, and provision is often made for either or both means of energizing, on the same machine. The present invention constitutes an improvement over the disclosure of Patent No. 1,561,506.

Due to the extremely high flywheel speeds desired, very high hand-crank gear ratios are necessary, while small high speed electric motors may operate at flywheel speed. Such motors, however, in the prior art, have been provided with an automatic coupling which is out of engagement, except when the motor is driving; this being done on account of the relatively high brush friction in conventional motors, which offers excessive resistance to hand cranking.

Objects of this invention, are to save weight and bulk, and to eliminate the necessity for disengaging couplings. Accordingly, the necessary laminations and conductors of the motor armature are here disposed at the appropriate radius to afford also the required mass moment of inertia for the flywheel rim, the stationary field members being preferably disposed within this rim. Assuming that the weights required for armature iron and copper, and for the flywheel rim are the same; it will be seen that a weight reduction of one-half is made by combining these functions in a unitary structure. It will also be seen, that by disposing the fields within the necessarily large rim, a very short structure, is afforded.

A further object of the invention is to provide a starter mechanism having an armature which may be energized either electrically, or manually, or simultaneously by both means as desired.

The highest practicable speeds are desired in the inertia means in these starters, in order to store the entire starting energy within a small mass; but the difficulty of restraining the conductors against centrifugal displacement from outwardly opening slots, limits the practicable speed with conventional armatures. A further object of this invention, accordingly, is to provide a structure which will combine the functions of flywheel and armature, and will avoid the foregoing speed limitation.

To eliminate brush friction when hand cranking is to be used, the brush springs here are loaded by a solenoid, which operates the starting switch, the connections being such that the brushes are applied before the switch closes, while the switch is opened before the brush spring tension is relaxed.

Various other objects and advantages of the invention will be in part obvious from an inspection of the accompanying drawings and a careful consideration of the following particular description and claims embodying my invention.

In the drawings:

Figure 1 is a longitudinal section of the present invention.

Figure 2 is a cross section taken on the line 2—2 of Figure 1 looking in the direction indicated by the arrow.

Referring to Figures 1 and 2, 1 designates the starter housing secured to the engine casing 2 as by bolts 3. The starter jaw 4 is drivably secured to the main gear 5 and is slidable into engagement with the engine jaw 6 by a suitable control means not shown. The main gear 5 engages the pinion 7 driven by the first reduction gear 8 from the flywheel or armature pinion 9. The main gear 5 is also provided with a bevel pinion 10 engaged with the hand cranking bevel gear 11 which may be operated manually by the crank 12.

Rigidly engaged with the pinion 9 is the armature or flywheel shaft 13 carrying rigidly the disk 14 to which is secured the laminations 15 as by screws 17, said laminations being provided with internal slots carrying the conductors 18 which are led down to the commutator 19. These laminations constitute the armature and are of annular formation and disposed at a relatively great radius so as to possess, together with the associated conductors, a sufficient mass moment of inertia to store kinetically, when rotated to

high speed, sufficient energy to effect a starting of the engine even though the electrical or manual energy by which such speed has been produced be discontinued.

Secured to the starter casing 1 is the motor casing 20 which includes the end wall 21 to which the fixed field poles 22 are secured as by screws 23. Extending from the wall 21 is a cylindrical part 25 surrounding the commutator and carrying the outboard bearing 26. This extension is provided with openings 27 through which the brushes 28 extend from their supporting rigging 29 which is accessibly placed exteriorly of the cylindrical extension 25.

The brush holders are adapted to oscillate on the support pins 24 and are connected for simultaneous movement through the rod 30 and the brush springs 31. A retraction spring 32 normally keeps the brushes out of contact with the commutator until current is applied, as from a battery 33 connected to the motor through contact bars 34 and 35 of the solenoid switch 36, the coil of the solenoid being connected by the leads 37, and 38 and a switch 39 to the battery. The solenoid plunger 40 is provided with a contact head 41 for establishing a connection across the contact bars 34, 35 and this plunger has an extension 42 cooperating with a lever 43 to load the brush springs 31 just before such contact is established; the spring 44 normally keeping the contact head 41 in its off position whilst the brushes are lifted from the commutator. The brush gear and solenoid are preferably covered by a quickly detachable light cover 45.

The operation of the device is as follows:—

For manual operation, the switch 39 is left open and the hand-crank 12 operated to gradually accelerate the armature-flywheel 15 to high speed through the bevel gears 10 and 11 and the high ratio gear train 5, 7, 8 and 9. All the energy developed by the operator is thus stored in the armature 15, which during manual cranking constitutes merely a flywheel having no electric function, the brushes being in their raised position, open-circuiting the machine and removing frictional and dynamo-electric resistance to the acceleration of the flywheel.

The usual jaw control, not shown, then is manipulated and the engine engaged according to the well-known practice with inertia type starters as disclosed, for example, in my Patent No. 1,561,506.

For electrical operation, the switch 39 is closed, energizing the solenoid 36 and drawing up its plunger 40 which, through the extension rod 42 and lever 43 first applies the brushes through the springs 31 and then holds the contact head 41 in electrical connection across the switch bars 34 and 35 establishing electrical connection between the fields and brushes and the source of current. This accelerates the armature-flywheel and, when sufficient speed has been attained, the switch 39 may be opened and the engine jaw engaged in the usual way; the starting energy being supplied by the momentum of the combined flywheel-armature 15.

When the engine starts it overruns the jaws 4 which automatically disengages and when the switch 39 is released the parts return to the position shown in Figure 2 with the brushes retracted from the commutator and, therefore, adapted for manual cranking without frictional resistance.

If it is desired to supplement this momentum energy by the torque from the motor, switch 39 may be left closed when the jaws are engaged, but in general the added torque would be slight since it is a characteristic of this type of starter that the electrical torque required is less than the inertia torque developed in the ratio of the energizing time to the actual starting time; which ratio may be of the order of 30 : 1.

It will be seen that, by the special disposition of armature whereby the masses necessary for the electrical parts such as the laminations and conductors are disposed at a sufficient radius to afford also the necessary flywheel effect, considerable saving in bulk and weight is achieved as compared to the structures of the prior art wherein an armature of conventional proportions is connected to a separate flywheel through an automatic coupling, which last two elements are eliminated in the structure of this invention. It will also be seen that since such couplings disconnect the armature when the flywheel has been energized such kinetic energy as has been impressed in the armature is wasted, whereas, in this invention all the energy impressed in moving parts is effectively utilized to start the engine.

It will further be seen that by conforming the armature to the diameter necessarily occupied by the flywheel means, a considerable saving in length is effected, while by disposing the conductors within the annular laminations, disruption due to the great centrifugal force generated by the high speed necessary in these machines is avoided.

By the structure disclosed the brushes are applied for electrical cranking before the starting current circuit is completed but they are raised after this circuit is opened whereby sparking at the brushes at such times is avoided.

It will be seen that the combination of an external rotor of an electric motor in the apparatus described is of the essence of this invention. For convenience of description the external rotor has been illustrated as comprising the "armature", the "fields" forming the stator. It should be understood, however, that this arrangement may be re-

versed, disposing the "fields" to form the external rotor and adapting the "armature" to comprise the stator, without departing from the spirit of this invention.

Variations may be resorted to within the scope of the invention and portions of the improvements may be used without the others, whilst not departing from the spirit of the invention.

Claims to the herein disclosed motor structure, per se, are being prosecuted in applicant's co-pending application Serial No. 358,373 filed April 26, 1929.

Having thus described my invention, I claim:

1. In a flywheel type starter, an inertia member comprising a motor armature, a commutator for said armature, brushes for the commutator, and means for applying the brushes before the motor circuit is completed and for retracting the brushes after said circuit has been broken.

2. In an inertia type starter, a member adapted to be moved into engagement with and to crank a member of the engine to be started, an inertia member comprising a motor armature mounted coaxially with and in driving relation with said driving member, a commutator for said armature, brushes for the commutator, means for automatically applying the brushes to the commutator as an incident to the closure of the motor circuit, and means for automatically retracting said brushes as an incident to opening the motor circuit to relieve the inertia member of the brush load.

3. In a self-contained inertia starter for internal combustion engines, a driving member adapted to engage and crank a member of the engine to be started, an inertia member mounted coaxially with said driving member and comprising the armature of an electric motor, means for drivably connecting said inertia member and said driving member, means including said last named means for actuating said inertia member by hand, means for actuating said inertia member electrically including a commutator for said armature and brushes for the commutator, and means for normally retaining said brushes out of contact with said commutator, except when the inertia member is actuated electrically.

4. In a self-contained engine starter of the type having a flywheel which also constitutes the armature of an electric motor, means for manually actuating said flywheel, additional means for electrically actuating said flywheel wholly disposed within its periphery, said means including a commutator and brushes, and means for applying and retracting said brushes to and from said commutator upon closing and opening the electrical circuit to said motor so as to relieve the flywheel of brush friction during hand actuation and during the cranking operation, said means including a solenoid adapted to apply the brushes upon energization, and spring means for retracting said brushes upon deenergization, of said solenoid.

5. In a self-contained engine starter of the inertia type, a driving member adapted to engage and crank a member of the engine to be started, a gear train including a slow speed gear drivably connected to said driving member and a high speed pinion coaxial therewith, a motor armature-flywheel having a shaft, said shaft being integral with said high speed pinion and being rotatably journaled at one end within said low speed gear, and means including said gear and pinion for actuating said armature-flywheel by hand.

6. In a self-contained starter for internal combustion engines, the combination of a driving member adapted to engage and crank a member of the engine to be started, a motor mounted coaxially with said driving member, said motor including an annular rotor constituting a flywheel and a stator mounted within said rotor, means for operatively connecting said rotor to said driving member, and means including said last named means for actuating said rotor as a flywheel by hand.

7. In an inertia type engine starter, a flywheel coaxial with but normally disconnected from the engine member to be rotated, said flywheel also constituting the rotor of a motor, a stator housed within the periphery of said flywheel, a driving member adapted to be moved into engagement with and to crank a member of the engine to be started, means including a gear train for drivably connecting said flywheel to said driving member, and means including said gear train for rotating said flywheel solely by hand, or for augmenting its rotation when used as a motor rotor.

8. A self-contained inertia type starter for internal combustion engines comprising a driving member adapted to be moved into engagement with and to crank a member of the engine to be started, a flywheel mounted coaxially with said driving member, a train of gears adapted to connect said flywheel to said driving member, means including said gear train for actuating said flywheel by hand, and means for electrically actuating said flywheel, said last named means being contained within the periphery of said flywheel.

9. In an engine starter, a rotatable member adapted to be moved into engagement with and to crank a member of the engine to be started and to remain out of said engagement during operation of the engine under its own power, actuating means comprising a motor and a circuit thereto, said motor being mounted coaxially of the axis of rotation

of said rotatable member and in driving relation therewith, a commutator for said motor, brushes for said commutator, means for electrically applying the brushes to the commutator as an incident to closure of the circuit to the motor, and means for automatically retracting said brushes from the commutator to relieve the armature of the brush load, said retracting means being operable incidentally to the opening of said motor circuit.

10. In an inertia type starter, a member adapted to be moved into engagement with and to crank a member of the engine to be started, an inertia member comprising the rotor of an electric motor mounted coaxially of and in driving relation with said driving member, a commutator for said motor, brushes for the commutator, means for automatically applying the brushes to the commutator, as an incident to the closure of the motor circuit, and means for automatically retracting said brushes as an incident to opening the motor circuit to relieve the inertia member of the brush load, said brush applying means comprising an electromagnetic device operatively connected to said brushes, and also to said motor circuit.

11. In an inertia type starter, a member adapted to be moved into engagement with and to crank a member of the engine to be started, and further adapted to remain out of said engagement during operation of the engine under its own power, an inertia member comprising the rotor of an electric motor mounted in coaxial driving relation to said driving member, a commutator for said motor, brushes for said commutator, electrically actuated means for applying the brushes to said commutator as an incident to energization of said motor, and means for automatically retracting said brushes as an incident to de-energization of said motor, to relieve the inertia member of the brush load.

Signed at Keyport, in the county of Monmouth, and State of New Jersey this 21st day of November, 1927.

ROLAND CHILTON.