Feb. 13, 1934. J. W. ALLEN 1,946,957

ENGINE STARTER

Filed June 28, 1932 2 Sheets-Sheet 1

Fig. 1

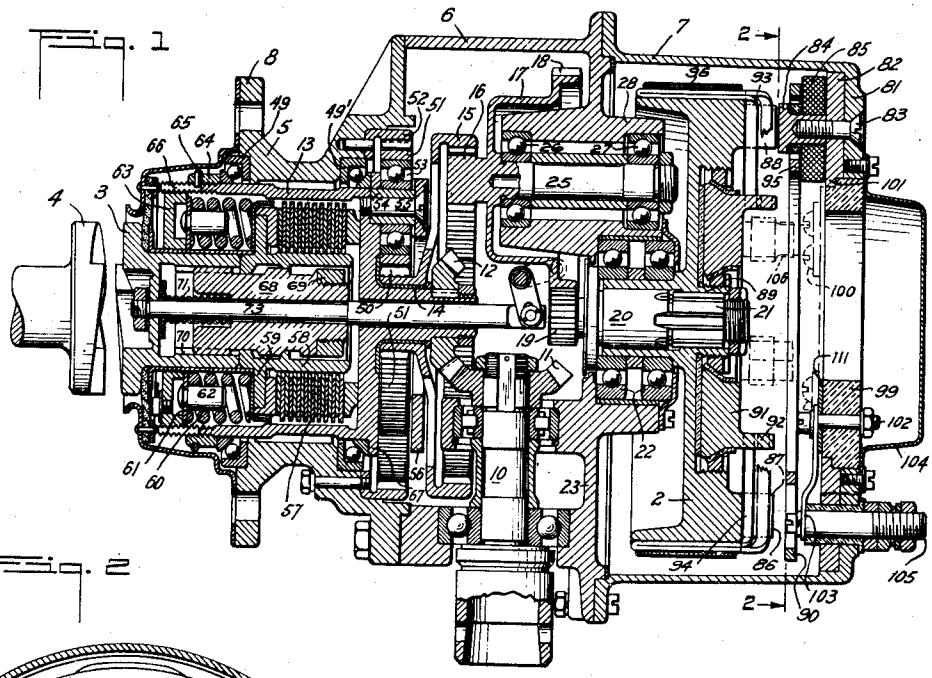


Fig. 2

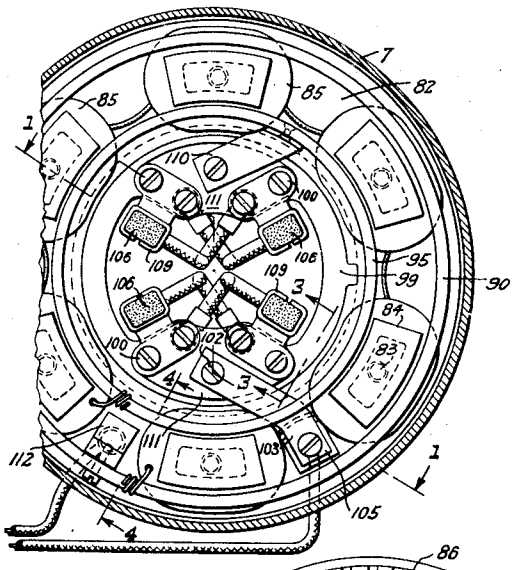


Fig. 3

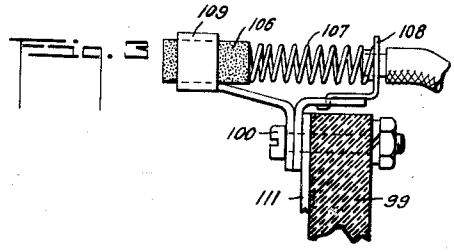


Fig. 4

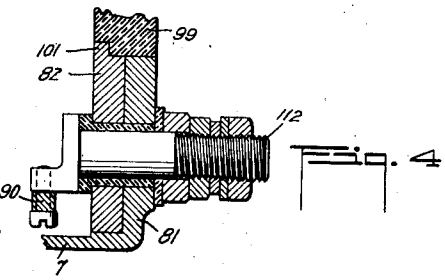
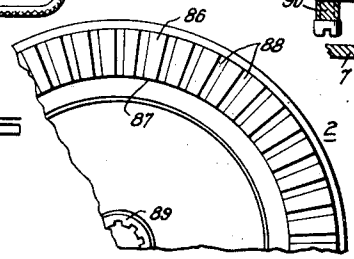


Fig. 5



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ENGINE STARTER

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Fig. 6

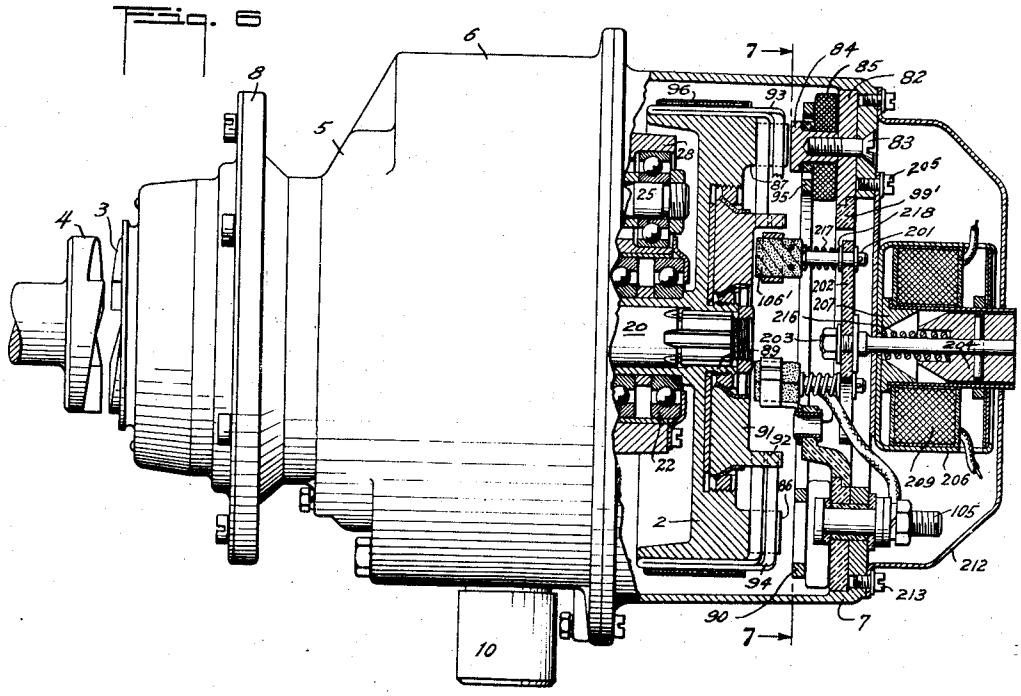
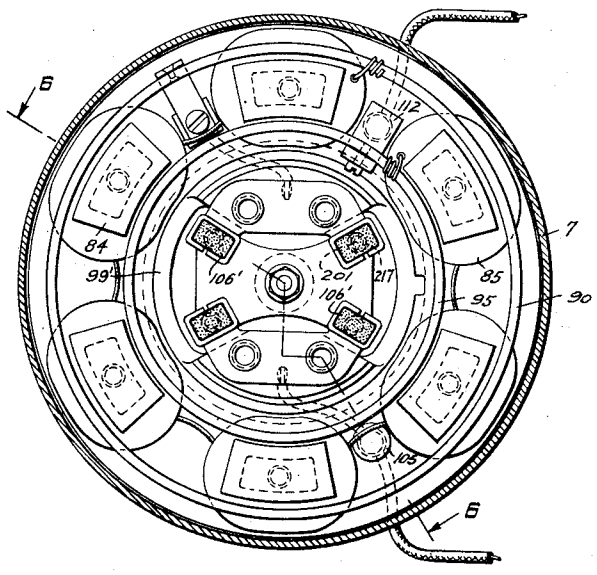


Fig. 7



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ENGINE STARTER

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Application June 28, 1932. Serial No. 619,757

20 Claims. (Cl. 290—38)

This invention relates to engine starters, and more particularly to a starter embodying a high speed inertia element of small size.

An object of the present invention is to provide a novel starter of the above character, wherein manual or power means, or both, may be employed for storing energy in the inertia member.

Another object is to provide novel starting apparatus employing as the prime mover, an electric motor of novel construction. In this connection, a feature of the invention is the provision of an electric motor particularly suited for engine starting service wherein it is desired to operate the motor for a certain time interval prior to connection of the motor to the engine to be driven. When so employed, the motor herein disclosed, by reason of the unusually large inertia effect of the armature, is capable of accumulating a substantial amount of kinetic energy during the process of accelerating to a relatively high speed, the said energy being thereafter available to transmit to a member to be driven, a much greater torque than could otherwise be exerted by the ordinary prime mover of proportionate dimensions.

A further feature of the invention, in this connection, is the provision of an electric motor for use in a starter, and characterized by a stator of novel construction, including a plurality of field coils which are wound about cores having their axes disposed substantially parallel to the axis of rotation of the armature, the apparatus being of small size and light weight.

These and other objects of the invention will become apparent from inspection of the following specification when read with reference to the accompanying drawings wherein is illustrated the preferred embodiment of the invention. It is to be expressly understood however, that the drawings are for the purpose of illustration only, and are not designed as a definition of the limits of the invention, reference being had to the appended claims for this purpose.

In the drawings,

Fig. 1 is a longitudinal section of a starter embodying the present invention;

Fig. 2 is a transverse sectional view along the line 2—2 of Fig. 1;

Figs. 3, 4 and 5 are detail views of motor parts;

Fig. 6 is a view partly in elevation and partly in section of a second embodiment;

Fig. 7 is a transverse view on line 7—7 of Fig. 6.

Referring to the drawings there is disclosed a combined hand and power actuated starter of a conventional inertia type, except for the fact that the inertia member, or flywheel 2 is of novel construction. As shown, the starter includes an engine-engaging clutch element 3 which is movable into driving engagement with a corresponding clutch member 4 provided on or connecting with the crankshaft or crankshaft extension of the engine to be started. The mechanism is housed within a suitable casing constituted by an inner section 5, an intermediate section 6, and a motor casing 7, the sections being removably secured together in any suitable manner, and the inner section 5 being provided with a flange 8 to facilitate the mounting of the starter on the engine crankcase, or in any other suitable location.

The manually operable means for actuating the starter preferably takes the form of a cranking shaft 10 rotatably mounted in intermediate housing section 6, with the outer end thereof projecting from said housing, and provided at its inner end with suitable means, such as a bevel pinion 11, for meshing engagement with a similar pinion 12 keyed to a combined shaft and barrel 13. The said shaft 13 is further provided with a bushing 14 on which is rotatably mounted the hub of an internally toothed gear 15 coaxially disposed with respect to the flywheel 2, and adapted to mesh with a pinion 16 made integral with a bell shaped member 17 provided at its opposite end with a skirt or flange constituting a spur gear 18 adapted to mesh with a pinion 19, the latter being preferably integral with a stub shaft 20 to which the flywheel 2 is rigidly secured by suitable means, such as the splines shown at 21. This stub shaft 20 is rotatably supported, as by ball bearing 22, in a suitable hub on a wall 23, extending across the section 6 of the starter casing. The bell-shaped member 17 is in turn rotatably supported, as by means of a stub shaft 25, bearings 26 and 27, in a compound boss 28 formed on wall 23.

The gear 15 is provided centrally thereof with an integrally formed pinion 50 which constitutes the sun gear for a plurality of planetary gears 51, one of which is shown in section in the drawings. These planetary gears 51, of which three are preferably employed, spaced at intervals of one hundred and twenty degrees about the sun gear 50, mesh with an internally toothed ring gear 52 which is rigidly secured in any suitable manner to the inner surface of housing section 5. Each planetary gear is rotatably mounted, as by a bearing 53, on a sleeve 54, the inner end of each sleeve being countersunk in the outer face of the closed end of barrel 13, into which extend screws 55. A retaining ring 56, carried by the outer end of each screw 55, maintains bearings 53 in their proper position on sleeves 54.

Means are preferably interposed between the transmission gear train above described and the engine-engaging member 3 for yieldingly transmitting energy from the flywheel to the engine crankshaft without damage to the parts, such as might result if the driving connections were en-

tirely constituted by rigidly connected elements. For this purpose a multiple disc clutch of the usual construction is preferably employed, the clutch comprising a plurality of annular discs 57 which are alternately splined to the inner surface of barrel 13 and to the outer surface of an interiorly threaded nut 58, and positioned between a flange 59 formed on the outer surface of nut 58 and the closed end of barrel 13. Suitable adjusting yielding means are also provided for holding nut 58 in operative position with respect to discs 57 and barrel 13, and for varying the frictional engagement of said discs. In the form shown, the yielding means comprises a plurality of coil springs 60 extending longitudinally of the barrel, with their outer ends having operative engagement with flange 59, and their inner ends exerting a thrust against an annular ring 61 mounted within the barrel and provided with a plurality of laterally projecting studs 62 which extend into the coils of springs 60, thereby maintaining them in proper spaced relation within the barrel. An adjusting nut 63 is threaded into the open end of the barrel and has abutting engagement with the inner face of ring 51. By adjusting the position of nut 63 longitudinally of barrel 13, the compression of springs 60 may be changed to vary the pressure with which the clutch discs 57 are engaged.

Exteriorly threaded to the inner end of barrel 13 is a ring 64, retaining the adjacent bearing 49. Ring 64 may be locked in position by means of a wire 65, one end of which passes through said ring and engages one of a plurality of longitudinal slots 66 formed in the open end of barrel 13, said ring being adapted to coact with a shoulder 67 formed on the closed end of the barrel and having engagement with the inner race of a second bearing 49' to prevent endwise movement of the barrel relative to the inner housing section 5.

Positioned within nut 58 is an exteriorly threaded shaft 68 adapted for rotary and longitudinal movement relative to said nut. The outer end of said shaft is provided with suitable means, such as a nut 69, adapted to engage a shoulder formed interiorly of nut 58 to limit longitudinal movement of the shaft to the left, as viewed in the drawings. The inner end of shaft 68 is longitudinally splined and extends into the correspondingly splined hub portion 70 of engine-engaging member 3, whereby these parts have positive driving engagement but are also adapted for relative longitudinal movement. A coil spring 71, surrounding a rod 73, preferably has its outer end extending into a recess formed in the inner end of shaft 68, and is interposed between said shaft and the outer face of engine-engaging member 3, to yieldingly impart an axially directed thrust from one to the other of said members. The rod 73 is adapted to be operated by suitable connections extending through the casing at right angles to the rod and functioning, for example, in the manner shown in U. S. Patent No. 1,786,118, granted December 23, 1930, to Raymond P. Lansing.

Having thus described the parts of one of a number of conventional starting mechanisms in which the present invention may be embodied, the elements entering into this preferred embodiment of the said invention will now be described.

Referring to Figs. 1 and 2, it will be seen that the section of the housing which encloses the flywheel 2 has an inwardly turned rim or annular portion 81 to which is secured, by suitable means 83, a second annular member 82 constituting part of the stator of an electric motor, the rotor of which is constituted in part by the flywheel 2. As shown, the stator comprises, in addition to the mounting ring 82, any suitable number of pole pieces 84, surrounded by field coils 85 and constituting with the ring 82, a part of the magnetic circuit of the field of the motor, each pole piece being suitably held to the ring 82, preferably by the aforesaid means 83. As shown, the pole pieces 84 are disposed with their axes in parallelism, and at equal radial distances from the axis of rotation of the flywheel 2. With this disposition, the outer faces of the pole pieces 84 can be plane-surfaced instead of concave as in the conventional motor construction, and are thus more readily adapted for electro-magnetic cooperation with the corresponding plane-surfaced face 86 of the laterally projecting rim 87 of the flywheel 2, the said rim 87 being radially slotted, as indicated at 88 (Fig. 5) to receive the armature winding. Interposed between the rim portion 87 of the flywheel and the hub portion 89 are the commutator assembly members 91 of current conducting material, the successive segments being separated by the usual insulating strips, and each segment having a laterally projecting annular bar 92 thereon for fastening the ends of the armature coils; the said coils also being incased in suitable insulating material. Two of such coils are shown at 93 and 94, as starting at one of the segment bars and passing through one of the slots 88 in the rim portion 87 of the flywheel, from which point the winding passes obliquely over the cylindrical periphery of the rim, and returns through an adjacent slot 88 to a complementary segment bar 92. If desired, a band 96 may be clamped around the portion of the windings adjacent the outer periphery of the flywheel to hold the windings in place.

The novel means for feeding current to the armature preferably takes the form of an insulating ring 99 set against the annular ledge 101 formed on the stator ring 82, and carrying screw 102 to which a suitable strip or lead 103 may be applied, the said screw being enclosed by a removable cap 104. This screw serves as the connecting means for one pair of the brushes 106, which, as shown, are secured by screws 100 to a base plate 111 which in turn is mounted upon ring 99, and as indicated in Fig. 2, these brushes are disposed in parallelism, with their ends urged against the outer face of the commutator segments 91 by suitable compression springs 107 seated in clips 108 which are held in place by the screws 100 which also serve to hold in place the brush holding boxes 109. A pair of conductor rings 90—95 is shown in Fig. 2 as concentrically disposed and serving to make electrical connections to the field post 112 and brush terminal 105 respectively, the ring 90 acting to connect the field coils to the terminal 112 and the ring 95 serving to carry the field current through strip 110, to one pair of brushes 106, and the commutator, thence through the other pair of brushes and strip 103, to terminal 105.

When power operation is desired, the current is caused to flow through windings of both rotor and stator whereupon there is developed in the rotor 2, due to its inertia effect, a considerable amount of kinetic energy after accumulation of which the operator actuates the meshing mechanism (only part of which is shown) to move the engine-engaging member 3 into mesh with the engine member 4. The energy stored in the rapidly rotating armature flywheel 2 is now effective

through the reduction gearing, the disc clutch and the members 3 and 4 to crank the engine and cause it to start under its own power, whereupon the overrunning action of jaw 4 is effective to move member 3 to the right into the position shown in Fig. 1; the shaft 68 being simultaneously returned to the position indicated in Fig. 1 by the reverse threading action concurrently produced.

There is thus disclosed a novel motor structure which, by reason of its inertia characteristics, is adapted for aplication to an inertia starter in which use it provides means whereby an engine may be cranked through energy stored in an inertia member which is accelerated either manually or by electric power. By mounting the field coils on the end wall, rather than on the lateral portion of the casing, a saving in the overall diameter of the motor is effected, while at the same time the axial length is kept well within the ordinary inertia starter dimensions by reason of the insertion of the commutator and the armature windings within the flywheel rim.

Although the invention has been shown applied to a specific type of engine starter, it is to be understood that the invention is not limited to the particular embodiment herein illustrated as various changes may be made in the construction and relationship of the component parts within the scope of the broadest of the appended claims. Thus, for example, if desired, means may be provided for normally holding the brushes out of engagement with the commutator so that there will be no friction load on the armature during the period of acceleration of the flywheel by the handcranking mechanism. One form of construction for this purpose is indicated in Figs. 6 and 7, wherein the brush holders 109' are mounted in an insulating ring 99' (corresponding to the ring 99 in Fig. 3) and the brushes 106' are connected to rods 201 mounted in a transversely disposed yoke 202 of suitable insulating material and centrally apertured to receive a threaded plunger rod 203 connecting with a movable core or plunger 204 of an electromagnetic device 206 suitably secured to a bracket removably attached to the end portion of the casing section 7 as indicated at 205, the said electromagnet 206 including a stationary magnetic piece 207 to which the movable core 204 is attracted upon passage of current through the winding 209 to the solenoid.

Substantially no other change is required in the construction shown in Figs. 1 to 5 and described above in detail, in order to incorporate this feature of electromagnetic control of the brushes, except that in place of the cover plate 104, a cover plate 212 of wider dimensions is substituted, said plate being attached to housing 7 as indicated at 213 and centrally apertured to allow the core 204 to project slightly in response to the action of the spring 216 on de-energization of the winding 209, the current to the winding being drawn from any suitable source, preferably the same as that supplying the current to the motor. Additional springs 217 preferably surround each of the rods 201 and yieldably press washer 218 against yoke 202 for a purpose similar to that of springs 107 described in connection with the preferred embodiment shown in Fig. 3.

Near the outer end of each of the rods 201 there is provided a transversely disposed pin which prevents the springs 217 from moving the brushes into engagement with the commutator prior to energization of the solenoid windings.

Likewise other changes may be made in the method of operation and application of the invention without departing from the novel principles thereof as defined in the following claims.

What is claimed is:

1. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a casing, a shaft rotatably supported therein and drivably connected to the high speed end of said gear train, a combined armature and inertia member comprising a hub drivably connected to said shaft and externally threaded, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, and means threadedly engaging both said hub and rim for retaining said commutator in place.

2. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a casing, a shaft rotatably supported therein and drivably connected to the high speed end of said gear train, a combined armature and inertia member comprising a hub drivably connected to said shaft and externally threaded, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, means threadedly engaging both said hub and rim for retaining said commutator in place, and a plurality of field coils longitudinally spaced from said rim and wound about axes passing through said rim.

3. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a combined armature and inertia member comprising a hub drivably connected to the high speed end of said gear train, a rim of relatively large mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, and means threadedly engaging both said hub and rim for retaining said commutator in place.

4. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a combined armature and inertia member comprising a hub drivably connected to the high speed end of said gear train, a rim of relatively large mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, means threadedly engaging both said hub and rim for retaining said commutator in place, and a plurality of field coils longitudinally spaced from said rim and wound about the axes passing through said rim.

5. In an engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a combined armature and inertia member comprising a hub drivably connected to the high speed end of said gear train, a rim of relatively large mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, means engaging both said hub and rim for retaining said commutator in place, and means for manually accelerating said inertia

member, said means including a cranking shaft drivably connected to said gear train.

6. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a combined armature and inertia member comprising a hub drivably connected to the high speed end of said gear train, a rim of relatively large mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, means engaging both said hub and rim for retaining said commutator in place, a plurality of field coils longitudinally spaced from said rim and wound about axes passing through said rim, and means for manually accelerating said inertia member, said means including a cranking shaft drivably connected to said gear train.

7. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, the combination of a casing having an annular ring of magnetized material secured thereto, a plurality of polar projections secured to said ring and casing at angularly spaced intervals about the axis of said casing, said polar projections being disposed in parallelism with their exposed faces located in a common plane substantially perpendicular to the axis of said casing, and a combined armature and inertia member drivably connected to the high speed end of said gear train and rotatable in said casing, said member having a laterally projecting annular portion, the outer face of which is adapted to rotate in a plane substantially parallel to and adjacent the plane of said polar faces.

8. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, the combination of a casing having an annular ring of magnetized material secured thereto, a plurality of polar projections secured to said ring and casing at angularly spaced intervals about the axis of said casing, said polar projections being disposed substantially in parallelism with their exposed faces located in a common plane disposed transversely of said casing, and a combined armature and inertia member drivably connected to the high speed end of said gear train and having an outer face which is adapted to rotate in a plane parallel to and adjacent the plane of said polar faces, a shaft journalled in said casing, and a hub on said inertia member, said hub being drivably connected to said shaft.

9. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, the combination of a casing having an annular ring of magnetized material secured thereto, a plurality of polar projections secured to said ring and casing at angularly spaced intervals about the axis of said casing, said polar projections being disposed in parallelism with their exposed faces located in a common plane perpendicular to the axis of said casing, and a combined armature and inertia member drivably connected to the high speed end of said gear train and rotatable in said casing, said member having a laterally projecting annular portion, the outer face of which is adapted to rotate in a plane parallel to and adjacent the plane of said polar faces, a shaft journalled in said casing and a hub on said inertia member, said hub being drivably connected to said shaft.

10. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, the combination of a casing having an annular ring of magnetized material secured thereto, a plurality of polar projections secured to said ring and casing at angularly spaced intervals about the axis of said casing, said polar projections being disposed in parallelism with their exposed faces located in a common plane disposed transversely of said casing, a combined armature and inertia member drivably connected to the high speed end of said gear train and rotatable in said casing, said member having a laterally projecting annular portion, the outer face of which is adapted to rotate in a plane parallel to and adjacent the plane of said polar faces, a shaft journalled in said casing, and a hub on said inertia member, said hub being drivably connected to said shaft.

11. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, the combination of a casing having an annular ring of magnetized material secured thereto, a plurality of polar projections secured to said ring and casing at angularly spaced intervals about the axis of said casing, said polar projections being disposed in parallelism with their exposed faces located in a common plane disposed transversely of said casing, a combined armature and inertia member drivably connected to the high speed end of said gear train and rotatable in said casing, said member having a laterally projecting annular portion the outer face of which is adapted to rotate in a plane parallel to and adjacent the plane of said polar faces, a shaft journalled in said casing, and a hub on said inertia member, said hub being drivably connected to the shaft, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, and means engaging both said hub and rim for retaining said commutator in place.

12. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, the combination of a casing having an annular ring of magnetized material secured thereto, a plurality of polar projections secured to said ring and casing at angularly spaced intervals about the axis of said casing, said polar projections being disposed in parallelism with their exposed faces located in a common plane perpendicular to the axis of said casing, said member having a laterally projecting annular portion, the outer face of which is adapted to rotate in a plane parallel to and adjacent the plane of said polar faces, a shaft journalled in said casing and drivably connected with the high speed end of said gear train, a hub drivably connected to said shaft, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, and means engaging both said hub and rim for retaining said commutator in place.

13. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a casing, a shaft rotatably supported therein and drivably connected to the high speed

end of said gear train, a combined armature and inertia member comprising a hub in driving relation with said shaft, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, brushes engageable with the outer end surface of said commutator, and means for moving said brushes into and out of engagement with said end surface.

14. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a casing, a shaft rotatably supported therein and drivably connected to the high speed end of said gear train, a combined armature and inertia member comprising a hub drivably connected to said shaft, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, brushes engageable with the end surface of said commutator, electro-magnetic means for moving said brushes into engagement with said end surface, resilient means for maintaining said brushes in engagement during energization of said electro-magnetic means, and additional resilient means for withdrawing said brushes upon de-energization of said electro-magnetic means.

15. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a casing, a shaft rotatably supported therein and drivably connected to the high speed end of said gear train, a combined armature and inertia member comprising a hub drivably connected to said shaft, a rim of relatively great mass integral with said hum, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, brushes engageable with the end surface of said commutator, electro-magnetic means for moving said brushes into engagement with said end surface, and resilient means for withdrawing said brushes upon de-energization of said electro-magnetic means.

16. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a casing, a field supporting element secured to the end wall of said casing, a shaft rotatably supported therein and drivably connected to the high speed end of the gear train, a combined armature and inertia member comprising a hub drivably connected to said shaft, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, brushes engageable with the end surface of said commutator, and mounting means for said brushes, said mounting means comprising a ring mounted within and concentrically of said field supporting element.

17. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a casing, a shaft rotatably supported therein and drivably connected to the high speed end of said gear train, a combined armature and inertia member comprising a hub drivably connected to said shaft and externally threaded, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, a plurality of field coils longitudinally spaced from said rim, an annular stator element having longitudinally extending projections supporting said field coils, and a brush mounting ring secured within and concentrically of said stator element.

18. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a casing, a shaft rotatably supported therein and drivably connected to the high speed end of said gear train, a combined armature and inertia member comprising a hub drivably connected to said shaft, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, a plurality of field coils longitudinally spaced from said rim, an annular stator element having longitudinally extending projections supporting said field coils, a brush mounting ring secured within and concentrically of said stator element, and means projecting through said ring for moving said brushes into and out of engagement with said commutator.

19. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a casing, a shaft rotatably supported therein and drivably connected to the high speed end of said gear train, a combined armature and inertia member comprising a hub drivably connected to said shaft, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, a plurality of field coils longitudinally spaced from said rim, an annular stator element having longitudinally extending projections supporting said field coils, brushes engageable with said commutator, and means projecting through said stator element for moving said brushes into and out of engagement with said commutator, said last named means including a plurality of rods disposed in spaced angular relation about axes located at equal radial distances from the axis of said shaft, and means connecting said rods for unitary movement.

20. In engine starting apparatus of the inertia type, in combination with an engine engaging member and a gear train drivably connected thereto, a casing, a shaft rotatably supported therein and drivably connected to the high speed end of the gear train, a combined armature and inertia member comprising a hub drivably connected to said shaft, a rim of relatively great mass integral with said hub, a recessed portion intermediate said hub and rim, a commutator positioned about said hub and within said rim, brushes for said commutator, a brush mounting ring secured within and concentrically of said casing, means projecting through said ring for moving said brushes into and out of engagement with said commutator, said last named means including a plurality of rods disposed in spaced angular relation along axes at equal radial distances from the axis of said motor, and means connecting said rods for unitary movement, said connecting means including a yoke of insulating material concentric with and disposed in the plane of said brush mounting means.

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