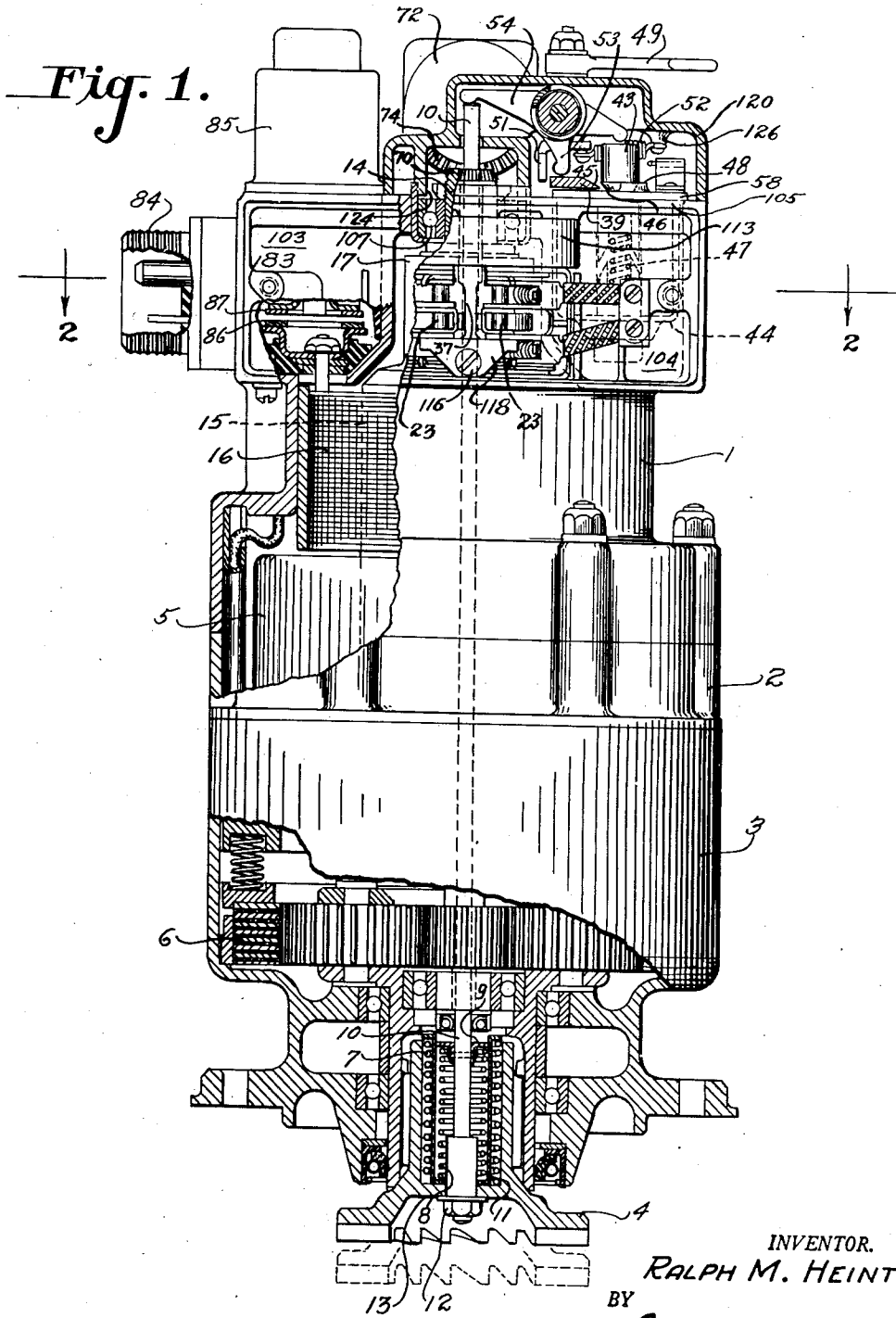


2,349,867

STARTER

Filed July 7, 1942

5 Sheets-Sheet 1



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2,349,867

STARTER

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5 Sheets-Sheet 2

Fig. 2.

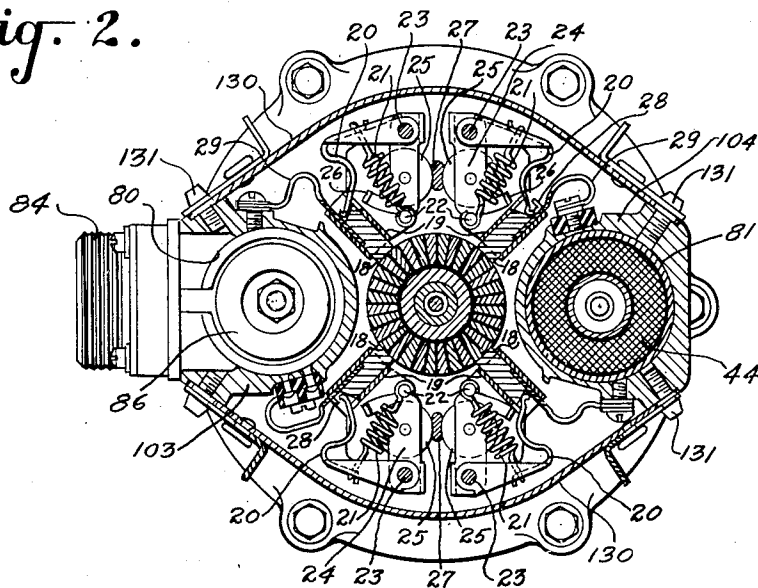
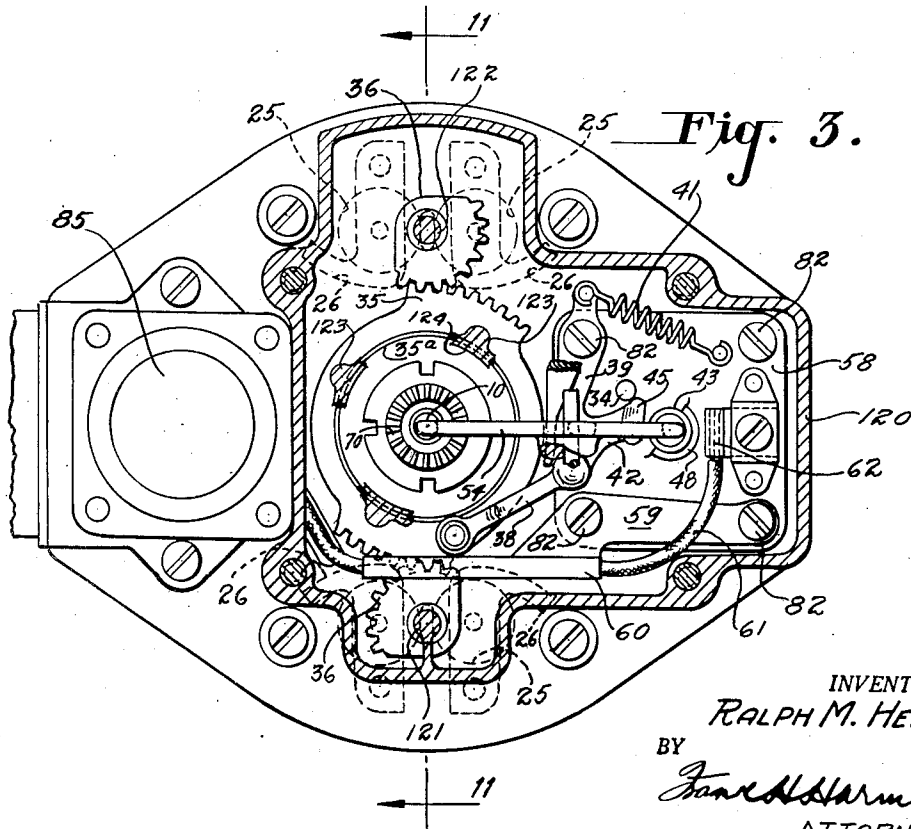


Fig. 3.



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STARTER

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5 Sheets-Sheet 3

Fig. 4

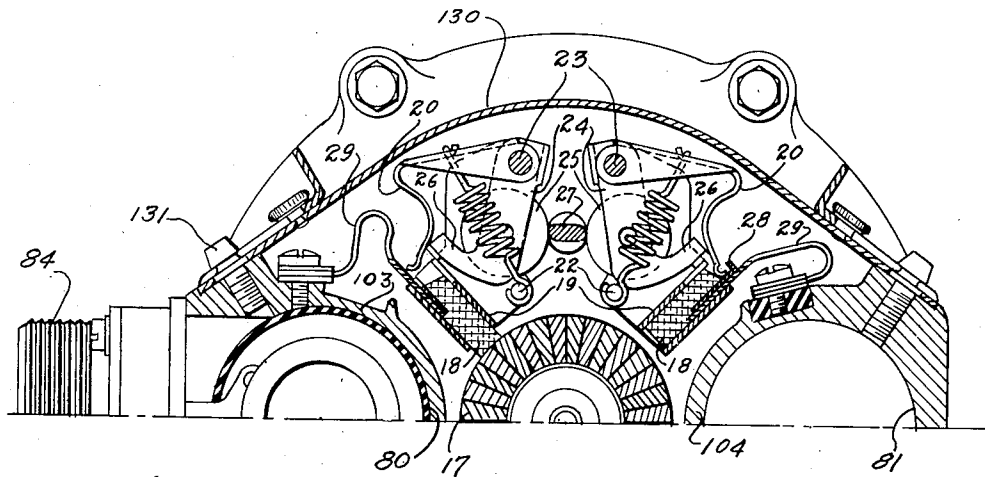
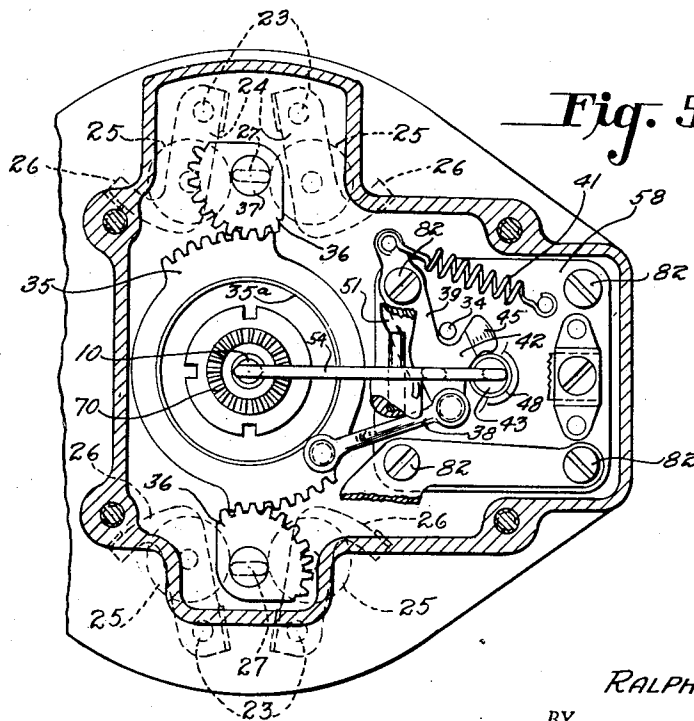


Fig. 5.



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2,349,867

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Fig. 6.

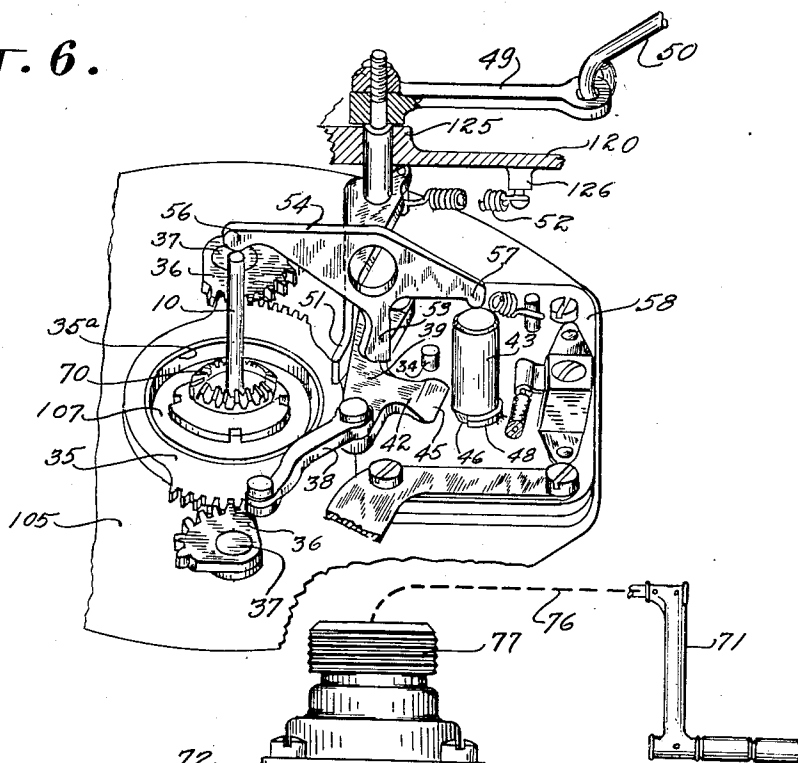
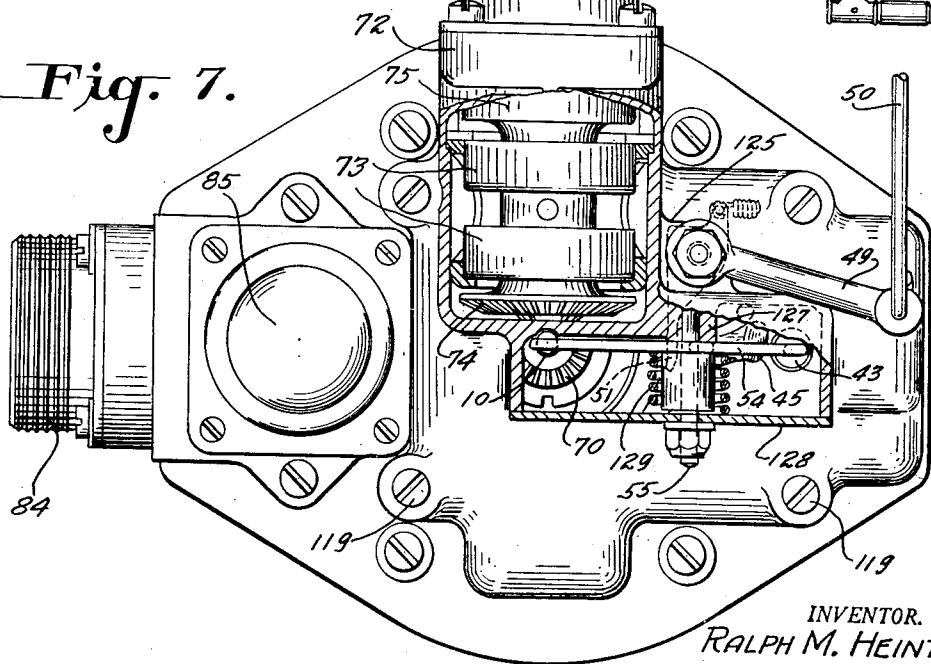


Fig. 7.



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Fig. 8.

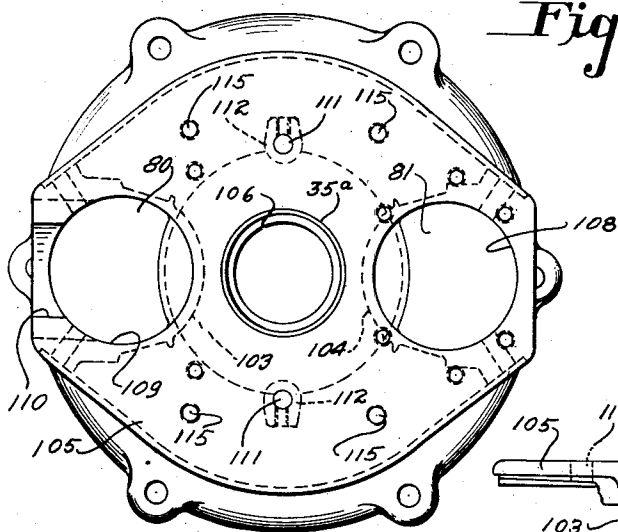


Fig. 9.

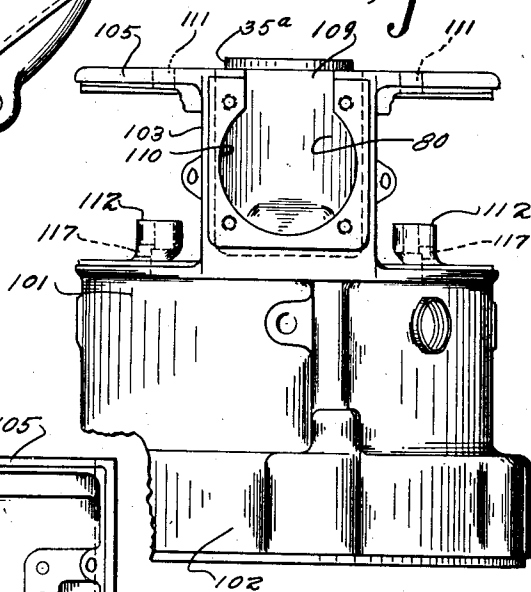


Fig. 10.

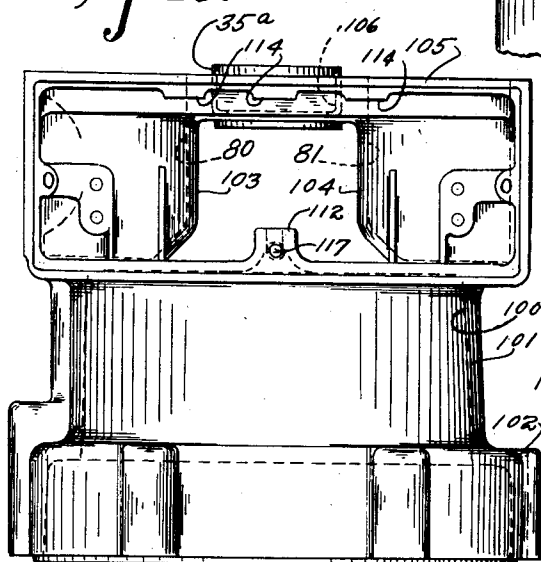
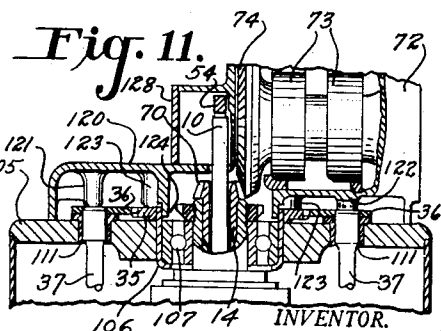


Fig. 11.



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UNITED STATES PATENT OFFICE

2,349,867

STARTER

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Application July 7, 1942, Serial No. 450,038

28 Claims. (Cl. 290—38)

The present invention relates to inertia type starters for internal combustion engines, such as aircraft engines and the like.

The general object of the invention is to provide an improved inertia or impulse type starter which may be either electrically or manually energized.

A particular object is to provide novel and improved brush lifting and jaw meshing mechanisms in a starter of the type described.

A further object is to provide a combined brush lifting and jaw meshing mechanism which may be operated electrically in conjunction with the electric starting motor, or manually in conjunction with associated hand cranking mechanism.

A still further object is to provide manually operated mechanism for retracting the brushes of the starting motor and operating jaw meshing mechanism, in combination with solenoid operated mechanism for releasing the brushes from retracted positions and for operating the jaw meshing mechanism.

Another object is to provide a novel motor frame, or housing, having wells therein to accommodate a jaw meshing solenoid and a relay or the like associated with a starter of the type described.

Additional objects and advantages will be apparent to those skilled in the art as the description proceeds in connection with the accompanying drawings, in which:

Figure 1 is an elevational view of a starter, with certain parts broken away, illustrating the principles of the invention;

Figure 2 is a sectional view taken approximately on the line 2—2 in Figure 1, showing the motor brushes in operative relation to the commutator;

Figure 3 is an enlarged top plan view of the starter with parts broken away to show a portion of the brush lifting and jaw meshing mechanism in positions consistent with Figures 1 and 2;

Figure 4 is an enlarged fragmentary sectional view taken as Figure 2, but showing the brush lifting mechanism in retracted position;

Figure 5 is an enlarged fragmentary plan view taken as Figure 3, but showing the brush lifting mechanism in retracted position consistent with Figure 4;

Figure 6 is a fragmentary perspective view showing the mechanism as it appears with the brushes lowered into operative relation with the commutator, as in Figures 1, 2 and 3;

Figure 7 is an enlarged top plan view with

portions of the top housing broken away, and including a diagrammatic representation of associated hand cranking mechanism;

Figures 8, 9 and 10 are plan and elevational views, respectively, of the motor frame, Figure 10 being taken at right angles to Figure 9; and

Figure 11 is a fragmentary sectional view approximately on the line 11—11 of Figure 3 and drawn to the same scale as Figures 1 and 2.

The principles of the invention are illustrated in a preferred embodiment of electric starter comprising a motor 1, a drive unit 2, and a control unit 3 connected together in end to end relation and axial alignment as shown in Figure 1.

In operation the starter is adapted to transmit a cranking torque to an internal combustion engine such as an airplane engine or the like to be started by means of a jaw clutch member 4 which may be extended to engage a similar

co-mating jaw member on the engine. The starter contains an inertia member, or flywheel 5 which may be energized by the electric motor 1 or by hand cranking mechanism to store sufficient energy to break the engine loose and accomplish the cranking thereof.

The jaw clutch member 4 is intended to be extended into cranking engagement with the engine only during the cranking operation, and preferably not until the flywheel energy has attained a value sufficient

to turn the engine at its normal cranking speed. The operation of extending the jaw clutch member is therefore left under the control of the pilot, or operator, and the present invention is chiefly concerned with novel and improved means for extending this member, for retracting and releasing the motor brushes, and for combining and correlating these operations in an improved manner.

By means of the mechanism herein disclosed the motor brushes may be lifted for hand cranking, and the jaw clutch member extended, by manipulation of a single operating member such as a pull cable accessible adjacent the hand crank. A pull on the cable prior to hand cranking latches the brush lifting mechanism in retracted position so that the flywheel may be driven at high speed through the motor shaft without brush friction on the commutator. When the flywheel has been accelerated to the desired speed, a second pull on the same pull cable will extend the jaw clutch member into engagement with the engine for cranking.

If the flywheel is to be energized by means of the motor the brush lifting mechanism is first unlatched by a self-contained solenoid which re-

leases the brushes for electrical cooperation with the motor armature. Upon acceleration of the flywheel to the proper speed a second energization of the solenoid will extend the jaw clutch member for cranking the engine. The switch for controlling the solenoid circuit may be located adjacent the switch for controlling the starter motor, preferably in the cockpit or pilot's compartment, in the case of an airplane. Thus the present invention provides for the accomplishment of a double function by the instrument used for extending the jaw clutch member. If the jaw clutch member is to be extended by the pull cable the brushes are lifted by that agency, and if the jaw is to be extended by the solenoid the brushes are released by the solenoid, avoiding a multiplicity of controls for the combinations of functions to be accomplished under different circumstances.

Compact association of the operating instrumentalities is achieved by means of a bilobate construction of the motor frame, or housing, in which a pair of lobes on opposite sides of the commutator provide wells for containing the above mentioned solenoid and a power relay or terminal connector.

The above mentioned objects and features of the invention which have been discussed in general terms will now be described in detail with reference to the preferred embodiment illustrated, in accordance with the patent statutes, so as to be fully understood by one skilled in the art.

The mechanism by which the rotational energy of the motor armature and flywheel is transmitted to the jaw clutch member 4 is not material to the present invention, but may be said to broadly include gearing in the units 2 and 3 to appropriately reduce the speed, and friction clutch means 6 to absorb the shock of suddenly applied loads and to prevent overstressing the parts. This drive and clutch mechanism is of the general type disclosed and claimed in my copending application Serial No. 403,406, filed July 21, 1941.

A spring 7 constantly urges the member 4 into its extended position, but outward movement is normally prevented by spring 8 bearing against a stop 9 on the push rod 10. The spring 8 seats within the cupped end of a stationary sleeve 11 and overpowers the spring 7, the push rod 10 being provided with a head or nut 12 abutting the outer surface of a web 13 in the member 4. The member 4 is therefore constrained to remain in its retracted position as shown in full lines in Figure 1 until and unless the push rod 10 is depressed. The structure just described for biasing the push rod and the jaw clutch member is described and claimed in my copending application Serial No. 439,751, filed April 20, 1942.

The novel features of the invention will first be described with particular reference to the functions accomplished by the various parts of the mechanisms and the novel cooperation existing therebetween, after which the details of construction and assembly will be described in greater detail.

In order to be actuated by mechanism on the commutator end of the motor, the push rod 10 is disposed axially through the control unit 3, the drive unit 2, and the motor 1, the motor armature and other centrally disposed parts having axial openings therethrough. The push rod may be constructed in one piece, or it may com-

prise a number of sections fitting together in end-to-end relation with the upper extremity projecting beyond the end of the hollow motor shaft 14.

In the motor 1, 15 designates the armature, 16 the stator, and 17 the commutator. The present motor is supplied with four sets of brushes 18 in stationary brush holders 19, as shown in Figure 2, the brushes being normally urged against the commutator by fingers 20 actuated by tension springs 21 anchored on fixed posts 22. The fingers 20 are pivotally mounted on posts 23 and are arranged to bear directly against the brushes. Also pivotally mounted on the posts 23 are frames 24 carrying rollers 25 of insulating material and having projections 26 for lifting the fingers 20, the frames 24 being movable independently of fingers 20 until the latter are engaged by the projections 26. The rollers 25 are thereby engageable by cams 27 to effect the lifting of the fingers 20 to remove the spring pressure from the brushes.

It is desirable in the present embodiment to insure that at least certain of the brushes will be positively lifted out of electrical contact with the commutator to break the circuit, and to accomplish this function those certain brushes may be provided with lugs 28 to be engaged by the tips of the fingers 20 when the latter are cammed outwardly. In the present instance the brushes on only one side of the line are provided with lugs 28, but it is to be understood that the lifting of all or none of the brushes may be made positive in action without affecting the operativeness of the invention, and such variations are contemplated as being within the scope of the invention. It is also to be understood that reference to brush lifting mechanism and the so-called lifting or retracting of the brushes, is not to be interpreted as requiring positive physical lifting means for the actual brush elements themselves, but only that the source of brush pressure is removed to allow the brushes free movement out of pressure contact with the armature. The terms lifting or retracting of the brushes are used in the specification and claims simply to mean the withdrawing or removing of spring pressure therefrom to reduce friction on the commutator when the flywheel is to be driven by hand crank mechanism. It is also within the scope of the invention to modify the lugs 28 which are shown as being formed on the terminal parts of the flexible pigtail connections 29. The functional characteristics of the cam operated brush lifting mechanism having been described, further reference to the structural features of this mechanism will be made presently as the description proceeds.

A double segment gear 35 bearing on an annular flange 35a meshes with the segment gears 36, 36 on the two cam shafts 37, 37 to rotate the cams 27, 27, the gear 35 being actuated by a link 38 connected with a latching lever 39 pivoted on one of the screws 82. A spring 41 (Figures 3 and 5) tends to maintain the parts in the positions illustrated in Figures 1, 2 and 3 with the brushes bearing on the commutator. Mechanism will presently be described for rotating the latching lever 39 in a counterclockwise direction as viewed in Figure 3 to lift the brushes, the parts then assuming the positions shown in Figures 4 and 5. Once the parts are thus moved, to lift the brushes, a latching tongue 42 on the lever 39 enters into latching engagement with a plunger 43 in a solenoid mechanism 44 to prevent

the parts from returning to the positions shown in Figures 2 and 3. To facilitate the latching operation the tongue 42 is preferably provided with a sloping cam surface 45, and the plunger 43 is necked down to furnish a cooperating conical surface 46. A solenoid spring 47 (Figure 1) normally seats the plunger on a stop surface 48. When the latching lever 39 moves from the position of Figure 3 to the position of Figure 5 it must cam up the plunger 43 so that a portion of the tongue 42 adjacent the cam surface 45 may pass under the necked conical surface 46. When the tongue 42 has cleared the plunger 43 the latter snaps down against stop 48 to prevent return movement of the tongue. When the solenoid is energized, the plunger is lifted, releasing the tongue 42 and allowing the brushes to snap back into engagement with the armature.

The lever 39 is moved into brush lifting position and latching engagement with plunger 43 by means of the external lever arm 49 which may have a pull cable 50 attached thereto to rotate it in a counterclockwise direction as viewed in Figures 6 and 7. The lever 49 operates an arm 51 within the casing and is biased clockwise by the spring 52. The arm 51 is adapted to engage the latching lever 39 to lift the motor brushes through the agency of the mechanism previously described, a stop 34 serving to limit the motion of levers 39 and 49. The arm 51 is also adapted to engage a bell crank extension 53 on a rocker arm 54 pivoted on a shaft 55. The rocker arm 54 has an end 56 adapted to engage and depress the axial push rod 10, and an end 57 adapted to be actuated by the solenoid plunger 43.

The solenoid 44 is carried by a plate 58 by means of which it is mounted in the motor 1 in a manner to be presently described. A bracket 59 having a conduit portion 60 integral therewith supports a conductor 61 for the solenoid circuit, terminal connection being made at 62, as shown in Figure 3.

The upper end of the motor shaft 14, as viewed in Figure 1, carries a bevel gear 70 adapted to be driven by hand cranking mechanism indicated diagrammatically by the numeral 71, as shown in Figure 7. A cylindrical housing portion 72 contains bearings 73 carrying a bevel gear 74 in mesh with the gear 70, and an over running clutch member 75 driven from a flexible shaft or the like 76. The clutch 75 is preferably of the type described and claimed in my copending application Serial No. 434,235, filed March 11, 1942. The connection with the hand cranking mechanism is arranged as a side connection in the present embodiment, but a longitudinally directed end connection may be made readily available by means of interchangeable parts, and it is contemplated that such modification is included within the scope of the invention.

When the starter is to be energized by the hand cranking mechanism, the pull cable 50 may be manipulated to move the arm 51 to latch the brush pressure fingers 20 in raised positions, certain of the brushes being lifted clear of the commutator to break the circuit. The jaw clutch member 4 will be momentarily extended by this operation but will be returned by spring 8 to its retracted position upon release of the pull cable. After operation of the hand crank to spin the flywheel 5 at a high speed, the pull cable may be operated a second time to again extend the jaw clutch member 4, whereupon the friction of the driving engagement between co-mating jaws on the starter and on the engine will maintain

such engagement until the jaw 4 ceases to deliver torque to the jaw on the engine. The second operation of the pull cable will have no effect upon the brush lifting mechanism since this mechanism will already have been latched in the position shown in Figures 4 and 5.

When the starter is to be energized by the motor, a momentary energization of the solenoid 44 will raise the plunger 43 to release the latching lever 39 allowing the brushes to return to the commutator under their normal operating spring pressure. Operation of the solenoid will momentarily extend the jaw clutch member 4, but, as in the case of hand cranking, this member will return to its retracted position if it is not exerting torque upon the engine to frictionally maintain the engagement once it is established. After operation of the motor 1 to accelerate the flywheel to operating speed, the solenoid may be momentarily energized a second time to extend the rotating jaw clutch member 4 into cranking engagement with the engine, this engagement being frictionally maintained until the engine starts, or until the motor 1 is deenergized.

It will be noted from Figure 2 that the brush operating cams, rollers, spring and pressure fingers are oppositely disposed on two sides of the commutator 17, leaving spaces available in the two remaining intervals between brushes. Wells 80 and 81 are disposed in these spaces, accommodating a relay and terminal assembly 83 and the solenoid 44, respectively. The solenoid is readily removable by removing the screws 82 and the electrical connection 62, as shown in Figure 3.

From the connection 62 the lead 61 runs to the assembly 83. In the present embodiment the assembly 83 comprises a laterally facing terminal receptacle 84 for receiving an electrical conduit, and an upwardly extending solenoid 85 having fixed and movable contact elements 86 and 87 associated therewith, best shown in Figure 1. The receptacle 84 carries the power circuit for the motor 1 as well as the control circuits for the relay solenoid 85 and the previously mentioned solenoid 44, the power circuit for the motor 1 being established through the relay contacts 86 and 87 under the control of the solenoid 85. To complete the circuit to solenoid 44 the lead 61 makes electrical connection with one of the terminal pins in the receptacle 84.

If it is not desired to include the relay in the starter the well 80 may be used exclusively for housing the terminal receptacle facing either laterally or upwardly, through either the side or top opening in the well, a cover plate being provided for the opening not occupied by the conduit receptacle.

Figures 8, 9 and 10 illustrate the motor frame, or housing, per se, having a novel structural design to accommodate the solenoid 44 and the assembly 83 as integral parts of the starter. This frame, designated generally by the numeral 100, has a cylindrical portion 101 carrying the stator 16, and a cylindrical portion 102 of larger diameter surrounding the flywheel 5, although both cylindrical portions may have the same diameter. The cylindrical portion 101 carries on its upper end, as viewed in Figures 1, 9 and 10, a bilobate extension adjacent the commutator comprising the two lobes 103 and 104, and an end plate 105, it being understood that these various parts are preferably cast as an integral

unit. The end plate 105 is provided with a receiver 106 for a motor bearing 107, the upstanding rim 35a therearound serving as a bearing for the double segment gear 35, as previously described.

The lobe 103 contains the previously mentioned well 80 for the assembly 83 and the lobe 104 contains the well 81 for the solenoid 44. The well 81 has a top opening 108 which is closed by the plate 58 carrying the solenoid 44 when the latter is in place in the well. The well 80 has a top opening 109 and a side opening 110 which may be joined together as shown. When the unit 83 is in place the solenoid 85 projects from and closes the top opening 109, and the terminal receptacle 84 projects from and closes the side opening 110. By virtue of this construction the solenoid 44 and the assembly 83 are carried as integral, though removable, parts of the starter.

Holes 111 carry the cam shafts 37, and lugs 112 are provided for seating the lower ends of these cam shafts and for securing the brush holders and operating mechanism. Referring to Figure 1, the four brushes are carried on two insulating blocks 113 on opposite sides of the commutator, between the motor frame lobes 103 and 104, leaving the lobal regions available for the jaw meshing and brush releasing solenoid and the terminal and relay assembly. Each brush holding and lifting mechanism operated by a cam shaft 37 is preferably constructed as a unitary sub-assembly comprising brush holders 19, pressure fingers 20, springs 21, posts 22 and 23, frames 24, and rollers 25 all carried by the blocks 113. These blocks are adapted to be secured against raised faces 114 on the end plate 105, internally threaded inserts or ferrules in the blocks receiving screws through holes 115 in the end plate 105, thereby accurately positioning the brushes with respect to the commutator. The lower portion of the brush assembly is secured to the above mentioned lug 112 by means of a screw 116 in the tapped hole 117 which passes through an insulating block 118 engaging the posts 23 near their lower ends. The four brushes 18 are carried by two identical assemblies as above described, these parts being normally covered by the cover plates 130 secured to fasteners 131.

A housing 120 carrying the motor end of the flexible drive shaft 76, and also carrying certain parts of the brush lifting and jaw meshing mechanism, is secured to the end plate 105 of the motor housing by screws 119. Abutments 121 and 122 integral with the housing 120 are positioned for axial engagement with the cam shafts 37 to prevent their displacement, these cam shafts being removable through the openings 111 when the housing 120 is removed. In a similar manner the housing 120 carries a plurality of abutments 123 around a circular rim or flange 124 to prevent displacement of the double segment gear 35 from its bearing on the annular flange 35a, the flange 124 fitting within the flange 35a and terminating just above the motor bearing 107. These features are best shown in Figures 3 and 11.

It will be seen that the housing 120, as above mentioned, also carries certain parts of the previously described brush lifting and jaw meshing mechanism. The lever 49 and arm 51 are journaled in a boss 125 in the housing 120, and the spring 52 is anchored on a post 126 extending inwardly of this housing. See Figures 1, 6 and 7. The shaft 55 carrying the rocker arm 54 is sup-

ported at one end in a boss or thickened portion 127 of the housing 120, the other end of the shaft serving as a securing means for a small cover plate 128. A compression spring 129 may be provided to hold the rocker arm against the end of the boss 127 and in alignment with the plunger 43 and push rod 10. The cylindrical housing portion 72, which is an integral part of the housing 120, carries the motor end of the flexible shaft from the hand crank and contains the bearings 73, bevel drive gear 74, and over running clutch 75 as previously described, the extremity of the portion 72 being provided with a threaded fitting 77 for receiving a conventional flexible shaft screwthreaded coupling element. The under side of the cylindrical portion 72 carries the previously mentioned abutment 122, appearing in Figures 3 and 11.

The single preferred embodiment herein shown and described is considered to represent the best embodiment of the principles of the invention, but it is to be understood that the present apparatus is only illustrative and that the invention can be carried out by other equivalent structure. Also, while it is intended to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the objects and advantages of the invention, and the invention is intended to include all such modifications. The invention is accordingly intended to be limited only by the prior art and the scope of the appended claims.

I claim:

1. In an engine starter having an inertia member and an extensible jaw clutch member, an electric motor for rotating said inertia member, resilient means for urging the brushes of said motor into contact with the motor commutator, manually operable means for retracting said resilient means and extending said jaw clutch member, means for latching said resilient means in retracted positions, and solenoid operated means for releasing said latching means and extending said jaw clutch member.
2. In an engine starter having an inertia member and an extensible jaw clutch member, an electric motor for rotating said inertia member, a hand cranking mechanism, resilient means for urging the brushes of said motor into contact with the motor commutator, manually operable means associated with said hand cranking mechanism for retracting said resilient means and extending said jaw clutch mechanism, and solenoid operated means associated with said motor means for releasing said resilient means from retracted positions and extending said jaw clutch member.
3. In an engine starter having an axially aligned motor unit, drive unit, control unit and extensible jaw clutch member wherein the commutator end of said motor and said jaw clutch member are disposed on opposite ends of said starter, a push rod passing axially through all of said units for extending said jaw clutch member, brush operating means on the commutator end of said motor, and a common mechanism on the commutator end of said motor for actuating said push rod and said brush operating means.
4. In an engine starter having an axially aligned motor unit, drive unit, control unit and extensible jaw clutch member wherein the commutator end of said motor and said jaw clutch member are disposed on opposite ends of said starter, a push rod passing axially through all of said units for extending said jaw clutch member,

brush operating means on the commutator end of said motor, and a common mechanism on the commutator end of said motor for actuating said push rod and said brush operating means, said common mechanism comprising manually operable means for retracting the motor brushes and extending the jaw clutch member, and electromagnetic means for releasing said brushes and extending said jaw clutch member.

5. In an engine starter having an axially aligned motor unit, drive unit, control unit and extensible jaw clutch member wherein the commutator end of said motor and said jaw clutch member are disposed on opposite ends of said starter, a push rod passing axially through all of said units for extending said jaw clutch member, brush operating means on the commutator end of said motor, and a common mechanism on the commutator end of said motor for actuating said push rod and said brush operating means, said common mechanism comprising a brush retracting lever connected with said brush operating means, a manually operable lever for moving said brush retracting lever, a latch for holding said brush retracting lever when so moved, a rocker arm adapted to be moved by said manually operable lever to operate said push rod, and solenoid means for releasing said latch and moving said rocker arm.

6. In an engine starter having an electric motor driven inertia member and an extensible jaw clutch member, a brush lifting lever, a manually operable lever for moving same, a latch for holding said brush lifting lever when so moved, a push rod for extending said jaw clutch member, a rocker arm movable by said manually operable lever to operate said push rod, and solenoid means for releasing said latch and moving said rocker arm.

7. In an engine starter, an electric motor, an extensible jaw clutch member, a push rod for extending said member, a rocker arm for operating said push rod, a brush lifting lever, a manually operable lever for actuating said rocker arm and said brush lifting lever, a plunger for actuating said rocker arm and unlatching said brush lifting lever, and solenoid means for operating said plunger.

8. In an engine starter, an electric motor, an extensible jaw clutch member, a push rod for extending said member, a rocker arm for operating said push rod, a brush lifting lever having a cam surface thereon, a manually operable lever for actuating said rocker arm and said brush lifting lever, a plunger for actuating said rocker arm, a cam surface on said plunger whereby said plunger is adapted to be cammed into latching engagement with said brush lifting lever when the latter is actuated by said manually operable lever, and solenoid means for operating said plunger to release said brush lifting lever and actuate said rocker arm.

9. In an engine starter, a motor, a pair of rotatable brush lifting members in said motor, means linking said members to rotate same in unison, a manually operable lever for operating said members to lift said brushes, a latch for retaining said lever in brush lifting position, and electromagnetic means for releasing said latch, said electromagnetic means also controlling clutch means in the power output of said motor.

10. In an engine starter, a motor, a manually operable brush lifting member in said motor adapted to hold the brushes in lifted positions and electromagnetic means for releasing said

member and for controlling clutch means in the power output of said motor.

11. In an engine starter, a motor, means for lifting the brushes in said motor, and a single electromagnetic means for releasing said brushes and for controlling clutch means in the power output of said motor.

12. In an engine starter, a motor, a manually operable lever for lifting the brushes in said motor, a latch for holding said lever in brush lifting position and electromagnetic means for releasing said latch and for controlling clutch means in the power output of said motor.

13. In an engine starter, an inertia member, hand crank mechanism for energizing said member, an electric motor having movable brushes for energizing said member, an extensible jaw clutch member, a single manipulable means for lifting said brushes and extending said jaw operable by a first manipulation to lift said brushes for hand crank energization of said inertia member, and operable by a second manipulation, after said energization, to extend said jaw into driving engagement with an engine to be started and a single electromagnetic means for releasing said brushes and extending said jaw operable by a first actuation to release said brushes for motor energization of said inertia member, and operable by a second actuation, after said energization, to extend said jaw into said driving engagement.

14. In an engine starter, a motor, a pair of rotatable brush lifting members in said motor, gear means on said members, gear means rotatable coaxially with the shaft of said motor and engaging said first named gear means for operating said members in unison, and a manipulable lever for rotating said second named gear means, said lever also controlling clutch means in the power output of said motor.

15. In an engine starter, an extensible jaw clutch member, a motor, a pair of movable brushes, pressure fingers for pressing said brushes against the commutator of said motor, cam means for lifting said fingers, a pair of rotatable shafts for operating said cam means, gear means on said shafts, gear means rotatable coaxially with the shaft of said motor and engaging said first named gear means for operating said fingers in unison, a biased lever for rotating said coaxial gear means, a spring latch for securing said lever against said bias, and electromagnetic means for releasing said latch and simultaneously extending said jaw clutch member to start an engine.

16. In a motor for an engine starter having cam actuated brush lifting means associated with hand cranking mechanism, a brush carrying assembly comprising an insulating block adapted to be mounted in said motor, a pair of brush holders on said block, a pair of posts in said block, spring actuated fingers pivotally mounted on said posts for engaging brushes in said holders, arms pivotally mounted on said posts for lifting said fingers and insulating rollers on said arms adapted for cam actuation.

17. In an engine starter and the like, an electric motor, reduction gearing and an extensible jaw clutch member all in axial alignment, a push rod for extending said member, said push rod being disposed axially through all of said above mentioned units, pairs of brushes in said motor, brush lifting mechanism disposed on opposite sides of the commutator of said motor and between said brushes, a pair of housings disposed on opposite sides of said commutator and be-

tween said brush lifting mechanisms, one of said housings containing electrical supply terminals, the other of said housings containing a solenoid and plunger combination, a rocker arm for transmitting motion of said plunger to said push rod, and latching means on said brush lifting mechanism actuatable by said plunger.

18. In an engine starter and the like having an electric motor and an extensible jaw clutch member, a hollow shaft in said motor, a jaw-extending push rod within said hollow shaft, a commutator on said shaft, brush lifting mechanism adjacent said commutator, mechanism for operating said brush lifting mechanism, latching means for holding said mechanisms in a predetermined position, and a solenoid having a plunger for operating said push rod and said latching means.

19. In an engine starter and the like having an electric motor and an extensible jaw clutch member, a hollow shaft in said motor, a jaw-extending push rod within said hollow shaft, a commutator on said shaft, brush lifting fingers pivoted adjacent said commutator, a pair of cams arranged on opposite sides of said commutator for operating said fingers, gear means for turning said cams, a gear concentric with said shaft meshing with said gear means, means for urging said gears toward a predetermined rotative position, means for latching said gears in a different position, a rocker arm for actuating said push rod and a solenoid mechanism adjacent said commutator and between said brushes for actuating said push rod and operating said latching means.

20. In a starter for internal combustion engines, said starter having an extensible jaw clutch member, a motor frame having a generally cylindrical portion, a bilobate extension on one end of said cylindrical portion, an end plate on said extension, an armature bearing receiver in said end plate, and means for mounting brush mechanism between the lobes of said extension, said lobes being of hollow construction and housing solenoid switch and jaw clutch operating means.

21. In a starter for internal combustion engines, said starter having an extensible jaw clutch member, a motor frame having a generally cylindrical body and a bilobate extension on one end of said body constituting the commutator end of said frame, said lobes being of hollow construction and housing solenoid switch and jaw clutch operating means.

22. In a starter for internal combustion engines, said starter having an extensible jaw clutch member, a motor frame having a generally cylindrical body and a bilobate extension on one end of said body constituting the commutator end of said frame, said lobes being of hollow cylindrical construction and housing solenoid switch and jaw clutch operating means, the axes of said cylindrical lobes being parallel to the axis of said body and said lobes providing a body thickness therethrough no greater than the diameter of said cylindrical body.

23. In an engine starter having an extensible jaw clutch member on one end of said starter and a motor on the other end, an axial push rod for operating said member, a frame for said motor comprising a cylindrical portion having a bilobate extension on the commutator end, each of said lobes being of hollow cylindrical construction, a removable solenoid in one of said lobes for operating said push rod, and a terminal recep-

tacle in the other of said lobes for making electrical connections to said motor and solenoid.

24. In an engine starter having an extensible jaw clutch member, a motor frame having a generally cylindrical body, a bilobate extension on one end of said body constituting the commutator end of said frame, said lobes constituting hollow wells for housing accessory devices, an end plate on said extension, an armature bearing receiver in said end plate, an upstanding annular rim on said bearing receiver projecting from said end plate, brush holding mechanisms mounted on said end plate between said lobes, cam shafts extending through said end plate for lifting the motor brushes, gears on said cam shafts and a gear mounted on said annular rim and meshed with said cam shaft gears to rotate said cam shafts in unison, and a solenoid in one of said wells for extending said jaw clutch member and controlling said brush holding mechanisms.

25. In an engine starter, a motor frame having a generally cylindrical body, a bilobate extension on one end of said body constituting the commutator end of said frame, said lobes constituting hollow wells for housing accessory devices, an end plate on said extension, an armature bearing receiver in said end plate, an upstanding annular rim on said bearing receiver projecting from said end plate, brush holding mechanisms mounted on said end plate between said lobes, cam shafts extending through said end plate for lifting the motor brushes, gears on said cam shafts, a gear mounted on said annular rim and meshed with said cam shaft gears to rotate said cam shafts in unison, a lever for rotating said gears to lift said brushes, a solenoid in one of said wells, a plunger in said solenoid adapted to latch said lever in brush lifting position, a jaw meshing push rod extending through said bearing receiver, and a rocker arm for operating said push rod by means of said plunger.

26. In an engine starter adapted for both hand crank and motor operation, a motor frame having a generally cylindrical body, a bilobate extension on one end of said body constituting the commutator end of said frame, said lobes constituting hollow wells for housing accessory devices, an end plate on said extension, an armature bearing receiver in said end plate, an upstanding annular rim on said bearing receiver projecting from said end plate, brush holding mechanisms mounted on said end plate between said lobes, cam shafts extending through said end plate for lifting the motor brushes, gears on said cam shafts, a gear mounted on said annular rim and meshed with said cam shaft gears to rotate said cam shafts in unison, a hand crank connection housing secured to said end plate, a plurality of abutments on said housing engaging said meshing gear, and abutments on said housing axially engaging said cam shafts, said abutments preventing the displacement of said meshing gear and said cam shafts.

27. In an engine starting system having an inertia member energized selectively by a motor or by a hand crank mechanism, an electric motor, cam operated brush lifting mechanism in said motor, a pair of cam shafts in said motor for operating said mechanism, gears on said cam shafts, a gear meshing with said gears to operate the latter in unison, a housing on said motor carrying a drive mechanism from said hand crank mechanism, and a plurality of abutments on said housing for engaging said cam shafts

and said meshing gear to prevent axial displacement thereof.

28. In an engine starting system adapted for both hand crank and motor operation, an electric motor having a frame with an end plate, cam operated brush lifting mechanism carried by said frame, a cam shaft in said frame for operating

said mechanism, said cam shaft being axially removable through said end plate, and a removable hand crank connection housing on said end plate covering the end of said cam shaft, said housing having an abutment adapted to axially engage said cam shaft to prevent displacement thereof.

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