May 18, 1943 R. M. NARDONE 2,319,469

ENGINE STARTING MECHANISM

Original Filed April 8, 1941 3 Sheets-Sheet 1

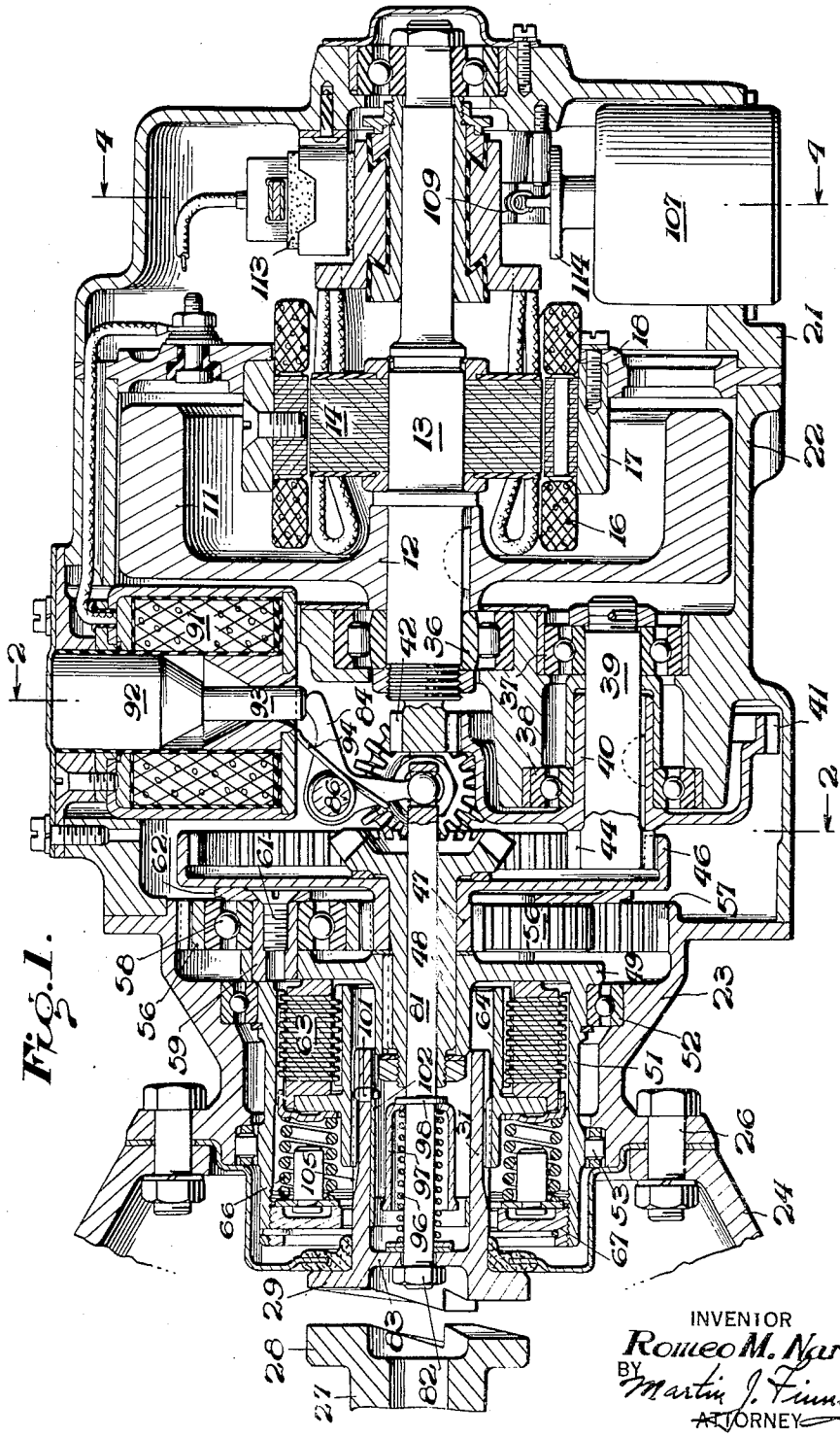


Fig. 1.

INVENTOR
Romeo M. Nardone
BY Martin J. Finnegan
ATTORNEY

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Fig. 2.

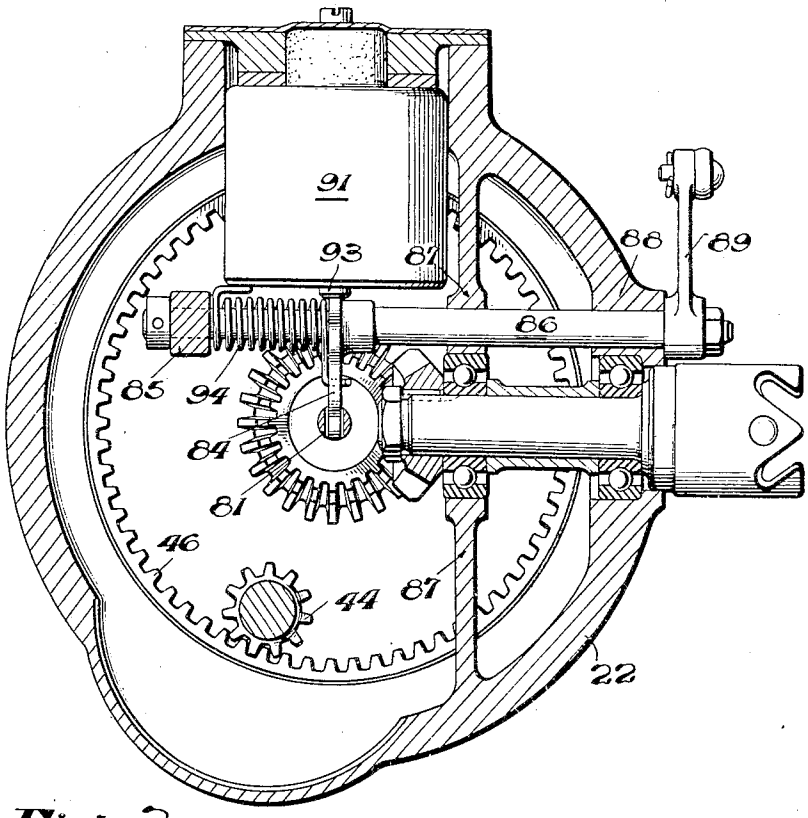


Fig. 3.

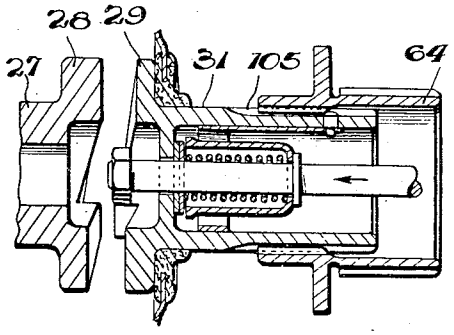
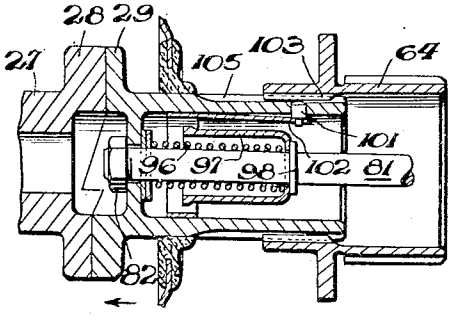


Fig. 4.



INVENTOR
Romeo M. Nardone.
BY
Martin J. Finnegan
ATTORNEY

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Fig. 5.

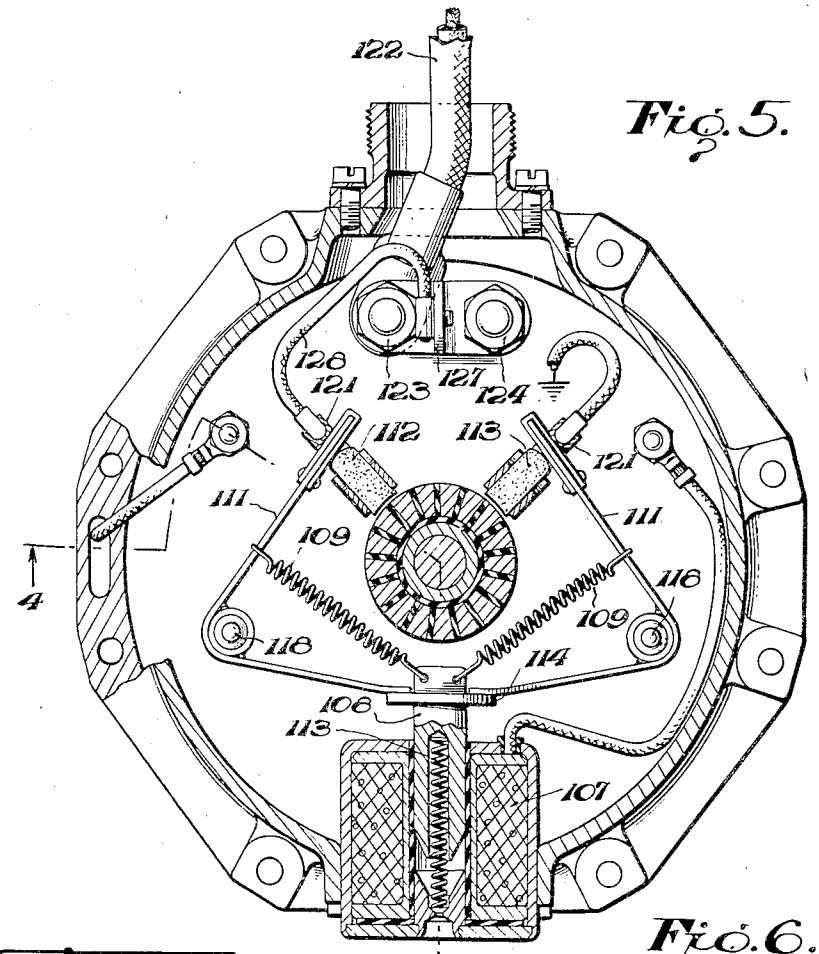
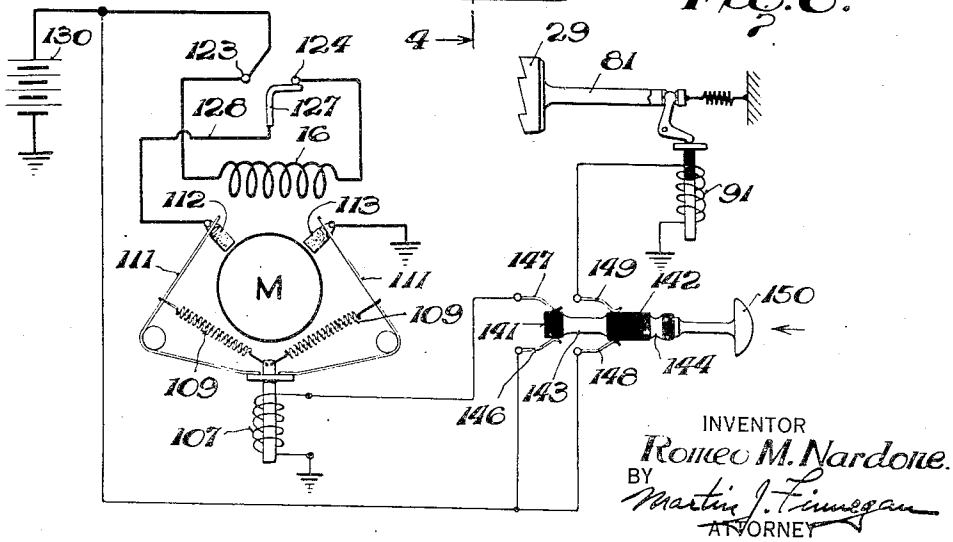


Fig. 6.



INVENTOR
Romeo M. Nardone.
BY
Martin J. Finnegan
ATTORNEY

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UNITED STATES PATENT OFFICE

2,319,469

ENGINE STARTING MECHANISM

Romeo M. Nardone, Westwood, N. J., assignor to Bendix Aviation Corporation, South Bend, Ind., a corporation of Delaware

Original application April 8, 1941, Serial No. 387,540. Divided and this application August 19, 1942, Serial No. 455,369

7 Claims. (Cl. 290—38)

This invention relates to internal combustion engines, and particularly to the starting of an internal combustion engine by impairing initial rotary movement to the engine crank-shaft through the agency of a mechanical torque transmitting starter mechanism. This application is a division of my application No. 387,540, filed April 8, 1941, now Patent No. 2,295,289, issued September 8, 1942.

An object of the invention is to provide an engine starter that can be readily adapted for rotation in a direction opposite to that originally prevailing, thus facilitating its application to an engine other than the one originally associated therewith.

Another object is to provide novel means for moving an engine-engaging member to engine-engaging position, following initial storage of energy in a driving member of the inertia type.

Another object is to provide novel means facilitating rotation of the inertia element (flywheel) in either desired direction, prior to operation of the means for moving the engine-engaging member to engine-engaging position.

Another object is to provide flywheel energizing means including a reversible electric motor having associated therewith brush lifting and reversing mechanisms of novel construction.

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 sectional view of a device embodying the invention;

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

Figs. 3 and 4 show the engine-engaging member and actuating means therefor, in successive stages of operation;

Fig. 5 is a view along line 5—5 of Fig 1; and

Fig. 6 is a diagram of electrical connections.

In Fig. 1 the inertia element 11 (flywheel) is shown as having a hub 12 keyed to the shaft 13 of the armature 14 of an electric motor whose field coils 16 are supported on a frame 17 fastened to a transverse plate 18 constituting part of a sectional housing; the said plate 18 being secured between the housing sections 21 and 22. A third housing section 23 supports the sections 22 and 21, and is in turn supported on a mounting flange 24 of the engine to be started; the sections 23 and 24 being held together by suitable bolts 26. A rotatable part 27 of the engine has ratchet teeth 28 for engagement by correspondingly shaped teeth on an engine-engaging member 29, and the latter has a cylindrical extension or hub 31 mounted for rotation and limited axial movement within the housing section 23.

Housing section 22 has an inwardly extending position with two openings—one to receive a bearing assembly 36 in which the shaft 13 rotates, and the other to receive a pair of bearing assemblies 37 and 38 in which a shaft 39 and a sleeve 40 have unitary rotation. Sleeve 40 is an extension of a bell-shaped gear 41 which meshes with a pinion 42, the latter being integrated with armature shaft 13 in any suitable manner.

Shaft 39 is keyed to sleeve 40 and terminates in teeth 44 to form a pinion having meshing relationship to the internally formed teeth of an annulus gear 46 whose hub 47 has relative rotation about a hollow shaft 48 that is drivably connected to the hub of a plate 49 constituting part of a barrel 51. Bearing assemblies 52 and 53 facilitate free rotation of barrel 51 in housing section 23.

Hub 47 of gear 46 has teeth, and these constitute a sun gear for mesh with a plurality of planetary gears 56 that are rotatably mounted on the barrel end 49 and mesh with an internal gear 57 which is shown as integral with the housing section 23. Preferably three planetary gears 56 are employed, and one of these is shown in section in Fig. 1. These gears 56 are preferably spaced 120° apart, so that as the view is taken in Fig. 1, one of the gears appears in elevation below the center line. Each of the planetary gears is rotatably mounted by means of a ball bearing 58 carried by a sleeve 59 which is held at its inner end in barrel end 49. Extending into sleeve 59 and threaded thereto is a screw 61 which supports the sleeve, bearing and planetary gear. If desired a retaining ring 62 for bearings 58 may be formed integral with sleeves 59.

For torque limiting purposes there is preferably employed a multiple disk clutch embodying a plurality of friction disks 63, a number of said disks being splined to the inner surface of barrel 51, and the remainder being splined to the outer surface of a shell or sleeve 64. Resilient means such as a plurality of coil springs 66 and an adjusting nut 67, which is threaded into the inner end of barrel 51, are provided for varying

the pressure with which disks 63 are maintained in engagement.

The novel engine-engaging control means, heretofore referred to, will now be described in detail. A rod 81 passes through hollow shaft 43, and at its outer end is threaded to receive a nut 82 which abuts the transverse apertured wall 83 of engine-engaging member 29 and thereby retains the said member 29 in assembled relationship to the rod 81 which passes freely through said apertured wall 83. At its other end rod 81 is formed to receive one end of a bell-crank 84 mounted on a rock-shaft 86 journaled in bearings 87 and 88 (Fig. 2) of the housing section 22, and projecting through said housing section 22 to receive a second bell-crank 89 for manual operation of rod 81. Automatic operation of rod 81, following initial acceleration of flywheel 11, is provided by solenoid 91 whose plunger 92 has an extension 93 which abuts the upper end of bell-crank 84 and moves the latter about its pivot in response to energization of winding 91 in the manner hereinafter described. A torsion spring 94 yieldably opposes such clockwise (Fig. 1) swinging of bell-crank 84, but this clockwise swinging is nevertheless effective to move rod 81 to the left. On the rod 81 there is a coiled compression spring 96 and a cup 97, the latter being normally urged against the rod collar 98 by the spring action. A detent 101 is urged in a radially outward direction by a leaf spring 102, and, because of this urging, it normally engages a tapered shoulder 103 (Figs. 1, 3 and 4) formed by the internal splines of sleeve 64, which splines coact with the external splines 105 on the hub 31 of engine-engaging member 29. This engagement of detent 101 with shoulder 103 holds member 29 against any axial displacement until the axial displacement of rod 81 fully compresses spring 96—in other words, until the parts reach the relative positions shown in Fig. 3. At that moment the continued pressure to the left of rod collar 81 (urged by the solenoid plunger 92), in conjunction with the now built-up stress in spring 96, results in a snap-action movement of member 29 to the left, into the position shown in Fig. 4. Thus engine engagement is effected, and the energy previously stored in flywheel 11 is transmitted to the member 27 of the engine, to "crank" the latter.

The previous storage of energy in flywheel 11 may have been by manual acceleration of the flywheel (through the gear train) or by motor operation. Motor operation involves an automatic brush applying action by electromagnetic control means now to be described.

Brush actuating solenoid 107 has a plunger 108 connected by means of springs 109 to clevis arms 111 which are loosely joined to brushes 112 and 113. Operation of the solenoid causes plunger 108 to move down (as shown on the drawings) so as to extend springs 109 and pull arms 111 down to apply pressure on top of the brushes 112, 113. The act of lowering the brushes to the commutator acts as a switch so that the motor is immediately energized and accelerates flywheel 11. When solenoid 107 is de-energized, the spring 113 acts to push the plunger 108 upward, and collar 114 contacts arms 111 to rotate them about their hinge points 118 and lift the brushes off the commutator by reason of the interengagement of said arms with the slots in the brush-carriers 121.

The rotation of the motor can be reversed merely by shifting the live lead 122 from terminal 123 to terminal 124, at the same time joining up brush 112 to terminal 123. Brush 112 is shown as connected to terminal 124. This reversal involves only a simple shift of conducting angle-strip 127 from one terminal to the other.

To control the flow of current from source 13 to the motor and solenoids 91 and 107, I employ a switch having a movable element with portions 141 and 142 of insulating material, and portions 143 and 144 of conducting material; also stationary fingers 146, 147, 148, and 149. A handle 150 enables the operator to close, first, the switch 146, 143, 147 to energize the solenoid 107 and thus apply the brushes to the motor. This allows current to flow through both the field coils 16 and armature 14 of the motor, in series, and the flywheel 11 is thus energized at high speed.

When sufficient energy has thus been stored, the operator pushes handle 150 further to the left, thus adding to the original circuit a second circuit passing to the solenoid 91 by way of contacts 148, 144, and 149. The member 29 is thereupon snapped into engine-engaging position (as heretofore explained) and the engine cranked.

When the engine starts, the operator returns switch 150 to the dead position (Fig. 6), and springs 113 and 94 now come into effect: spring 113, to lift the brushes from the commutator (Fig. 6); and spring 94, to restore rod 81 to its normal (Fig. 1) position, and—along with it—the member 29.

What is claimed is:

1. In an inertia starter, the combination with a flywheel and engine-engaging member, of means for accelerating said flywheel to relatively high speed, said means further operating to rotate said engine-engaging member at relatively low speed, means rotating with said engine-engaging member for yieldably restraining axial movement of said engine-engaging member during such rotation, compressible resilient means for producing axial (engine-engaging) movement of said engine-engaging member, and means for compressing said resilient means sufficiently to cause said resilient means to impart engine-engaging movement to said engine-engaging member.

2. In an inertia starter, the combination with a flywheel and engine-engaging member, of means for accelerating said flywheel to relatively high speed, said means further operating to rotate said engine-engaging member at relatively low speed, means rotating with said engine-engaging member for yieldably restraining axial movement of said engine-engaging member during such rotation, compressible resilient means for producing axial (engine-engaging) movement of said engine-engaging member, and means for compressing said resilient means sufficiently to cause said resilient means to impart engine-engaging movement to said engine-engaging member, said last-named means including a cup-shaped element enveloping said resilient means, and acting upon said engine-engaging member to release it from the restraint of said restraining means in response to the energization of said compressing means.

3. In an inertia starter, the combination with a flywheel and engine-engaging member, of means for accelerating said flywheel to relatively high speed, said means further operating to rotate said engine-engaging member at relatively low speed, means rotating with said engine-engaging member for yieldably restraining axial movement of said engine-engaging member during

such rotation, compressible resilient means for producing axial (engine-engaging) movement of said engine-engaging member, and means for compressing said resilient means sufficiently to cause said resilient means to impart engine-engaging movement to said engine-engaging member, said last-named means including a cup-shaped element enveloping said resilient means, and acting upon said engine-engaging member to release it from the restraint of said restraining means in response to the energization of said compressing means, and means for energizing said compressing means.

4. In an inertia starter, the combination with a flywheel and engine-engaging member, of means for accelerating said flywheel to relatively high speed, said means further operating to rotate said engine-engaging member at relatively low speed, means rotating with said engine-engaging member for yieldably restraining axial movement of said engine-engaging member during such rotation, compressible resilient means for producing axial (engine-engaging) movement of said engine-engaging member, and means for compressing said resilient means sufficiently to cause said resilient means to impart engine-engaging movement to said engine-engaging member, said last-named means including a cup-shaped element enveloping said resilient means, and acting upon said engine-engaging member to release it from the restraint of said restraining means in response to the energization of said compressing means, and means for energizing said compressing means, said energizing means including an electromagnetic device interposed between said flywheel and engine-engaging member, a source of current, and electric connections extending from said source of current to said electromagnetic device.

5. In an inertia starter, the combination with a flywheel and engine-engaging member, of means for accelerating said flywheel to relatively high speed, said means further operating to rotate said engine-engaging member at relatively low speed, means rotating with said engine-engaging member for yieldably restraining axial movement of said engine-engaging member during such rotation, compressible resilient means for producing axial (engine-engaging) movement of said engine-engaging member, and means for compressing said resilient means sufficiently to cause said resilient means to impart engine-engaging movement to said engine-engaging member, said last-named means including a cup-shaped element enveloping said resilient means, and acting upon said engine-engaging member to release it from the restraint of said restraining means in response to the energization of said compressing means, and means for energizing said compressing means, said energizing means including an electromagnetic device interposed between said flywheel and engine-engaging member, a source of current, and elastic connections extending from said source of current to said electromagnetic device, said electric connections including a switch having two operative positions, in one of which current flows from said source to said accelerating means continuously during energization of said electromagnetic device.

6. In an inertia starter, the combination with a flywheel and engine-engaging member, of means for accelerating said flywheel to relatively high speed, said means further operating to rotate said engine-engaging member at relatively low speed, and means for causing movement of said engine-engaging member to engine-engaging position, said last-named means including an electromagnetic device interposed between said flywheel and engine-engaging member, a source of current, and electric connections extending from said source of current to said electromagnetic device, said electric connections including a switch having two operative positions, and commutator brush-engaging means in circuit with said switch when the latter is in one of said operative positions, said brush-engaging means being cooperative with said switch to maintain current flow from said source to said accelerating means continuously during energization of said electromagnetic device.

7. In an inertia starter, the combination with a flywheel and engine-engaging member, of means for accelerating said flywheel to relatively high speed, said means further operating to rotate said engine-engaging member at relatively low speed, means for causing movement of said engine-engaging member to engine-engaging position, a source of current, a switch having two operative positions, and commutator brush-engaging means including an electromagnetic device in circuit with said switch when the latter is in one of said operative positions, said brush-engaging means being cooperative with said switch to maintain current flow from said source to said accelerating means continuously during energization of said electromagnetic device.

ROMEO M. NARDONE.