Dec. 27, 1938. J. W. ALLEN 2,141,331

ENGINE STARTING APPARATUS

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Fig. 2.

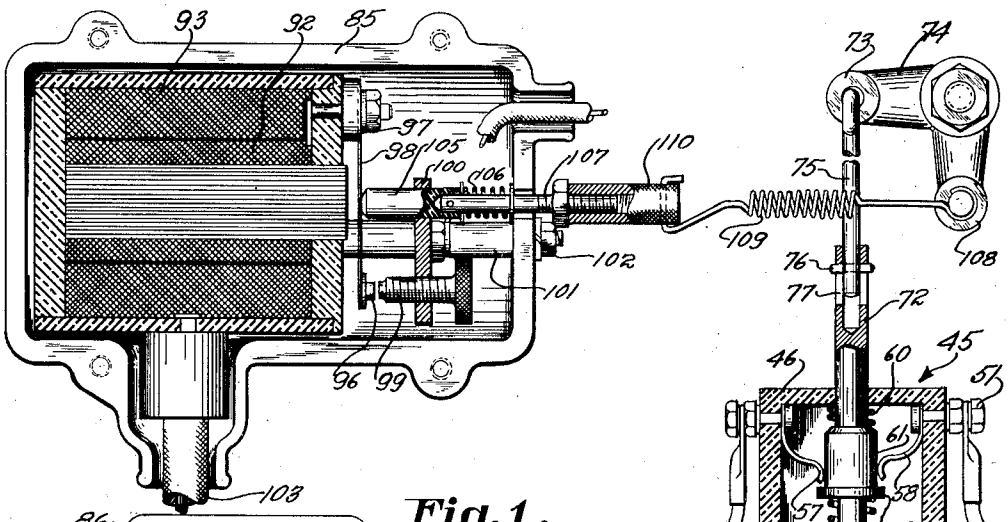
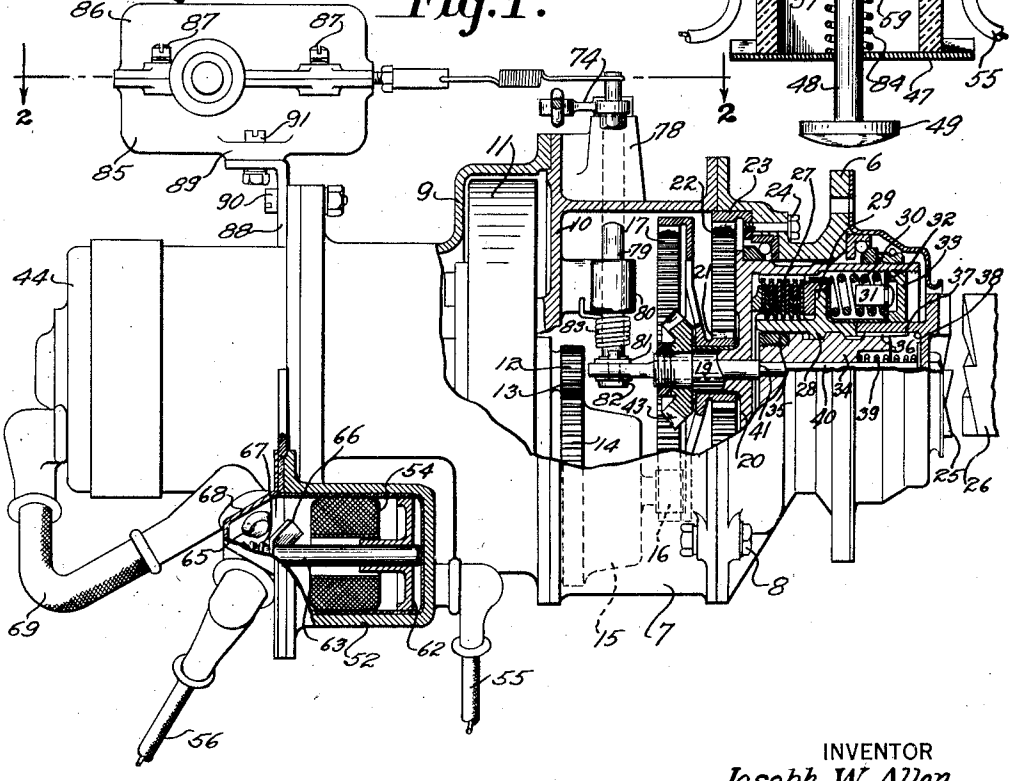


Fig. 1.



INVENTOR
Joseph W. Allen.

BY F. B. Smith.
ATTORNEY

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ENGINE STARTING APPARATUS

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Fig. 3.

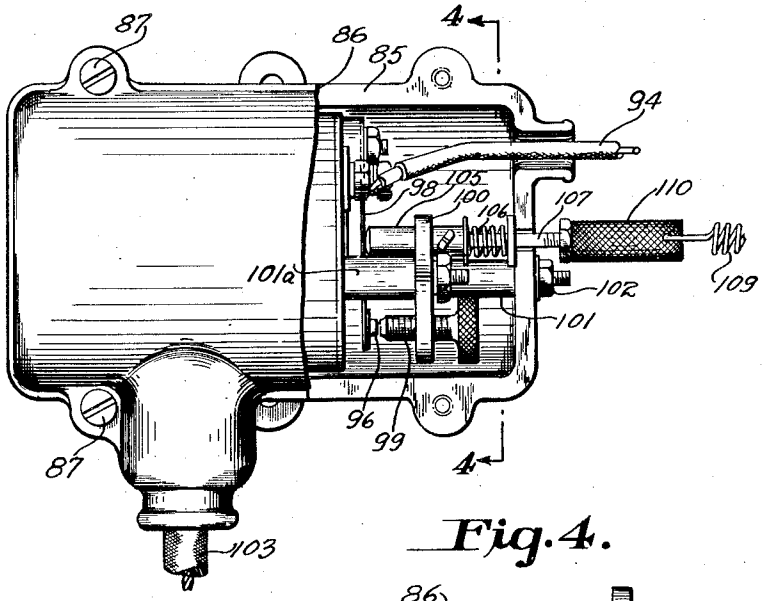


Fig. 4.

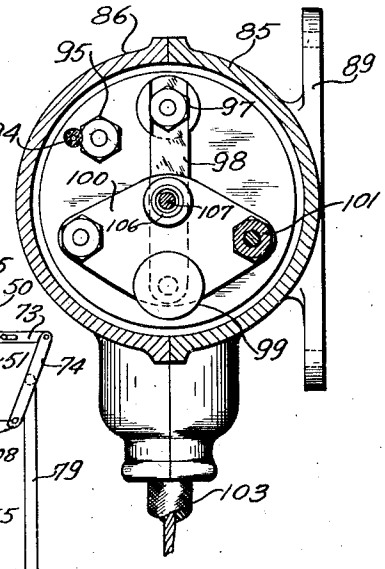
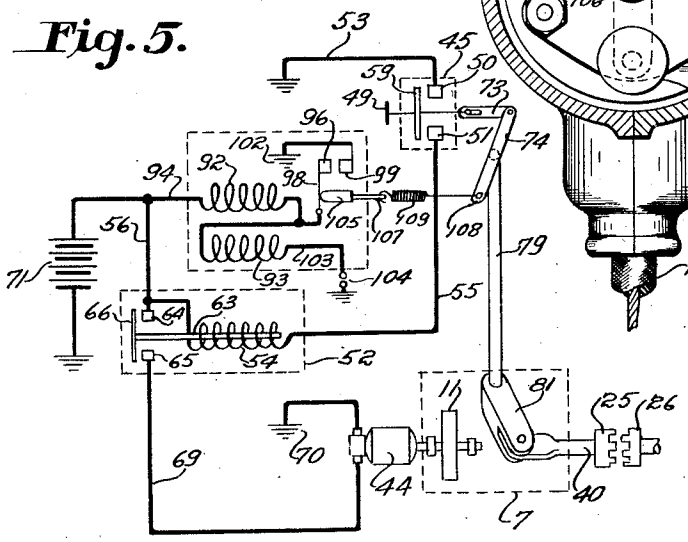


Fig. 5.



INVENTOR
Joseph W. Allen.
BY J. B. Smith.
ATTORNEY

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UNITED STATES PATENT OFFICE

2,141,331

ENGINE STARTING APPARATUS

Joseph W. Allen, East Orange, N. J., assignor to Eclipse Aviation Corporation, East Orange, N. J., a corporation of New Jersey

Application October 13, 1930, Serial No. 488,495

14 Claims. (Cl. 290—38)

The present invention relates to starting apparatus for internal combustion engines, and more particularly to engine starters of the inertia type embodying an inertia member adapted for high speed rotation.

One of the objects of the invention is to provide in an engine starting mechanism of the inertia type, novel means whereby the acceleration of the inertia member and the imparting of the energy stored in said member to a member of the engine to be started may be controlled.

Another object is to provide in engine starting mechanism of the inertia type, novel ignition current supply means for the engine being started adapted to be controlled simultaneously with the imparting of the energy from the inertia member to the engine member above referred to.

Another object is to provide novel control means embodying a unitary structure whereby the above functions may be controlled from a single control point, as for example, from the instrument panel of an aircraft.

Another object is to provide in combination with an engine starter of the type embodying an inertia member and a driving member adapted to be moved into cranking engagement with a member of the engine to be started, novel auxiliary ignition current supply means and means for actuating the driving member into engagement with the engine member after the inertia member has been accelerated and for simultaneously rendering said ignition current supply means operative.

Another object is to provide in combination with an engine starter of the above type including means for accelerating the inertia member, and a member adapted to be moved into cranking engagement with a member of the engine to be started, novel ignition current supply means and means whereby said ignition supply means may be energized and said engine engaging member simultaneously moved into engagement with the engine member after the inertia member has been accelerated and the accelerating means de-energized.

Another object is to provide in combination with an engine starter of the above type, novel auxiliary ignition current supply means adapted to be automatically rendered operative during the cranking operation of the engine for supplying ignition current to the engine during starting.

A further object is to provide an ignition current supply device embodying novel means for controlling the same.

A still further object is to provide in combination with an engine starter having a member adapted to be moved into cranking engagement with an engine to be started and a novel ignition device for supplying ignition current to said engine during starting, means for moving said engine engaging member into engagement with a member of the engine to be started and simultaneously rendering said ignition device operative with the actuation of the engine engaging member.

The above and other objects and advantages will appear more fully hereinafter from a consideration of the detailed description which follows with reference to the accompanying drawings, wherein is illustrated one embodiment of the invention. It is to be expressly understood, however, that the drawings are for the purpose of illustration only, and are not to be construed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is a view in elevation, with parts broken away and parts in section, of starting mechanism embodying the present invention;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1 of one form of ignition supply means and control means therefor embodying the invention;

Fig. 3 is a plan view of the ignition device shown in Fig. 2 with a portion of the casing broken away;

Fig. 4 is a transverse section taken on line 4—4 of Fig. 3; and

Fig. 5 is a schematic wiring diagram of the ignition supply device and the electrical and mechanical controlling means, the latter being represented diagrammatically.

Referring to the drawings, and more particularly to Fig. 1, the starting mechanism embodying the novel ignition supply means of the present invention includes a suitable casing having an inner end section 6 adapted to be secured to the crank case (not shown) of the engine to be started in any suitable manner, an intermediate section 7 secured to section 6 in any suitable manner, as by means of bolts 8, and an outer end section 9 secured to the intermediate section, as by means of bolts (not shown). An end plate or diaphragm 10 preferably formed integral with the intermediate section 7 is provided for supporting an inertia member 11 in the form of a flywheel of relatively small size and light weight, and adapted for high-speed rotation so as to

store energy therein which is adapted to be used for cranking the engine to be started.

Means are provided for imparting the energy stored in the rapidly rotating flywheel 11 to the engine to be started through a suitable train of reduction gearing which, in the form shown, includes a stub shaft 12 extending through the hub of flywheel 11 and held therein in any suitable manner. A small pinion 13 is formed on the inner end of the stub shaft 12, which is adapted to mesh with a relatively large pinion 14 formed on the periphery of a bell-shaped member 15, the latter being rotatably mounted in the lower portion of the end plate 10. A pinion 16, formed on the inner end of the bell-shaped member 15, is arranged to mesh with a relatively large internal gear 17 which is rotatably mounted in any suitable manner, as by means of a hub portion 18, on a short hollow shaft 19 which extends outwardly from the closed end of a barrel-shaped member 20, of which the hollow shaft is a part. A pinion 21 formed on the hub portion 18 constitutes a sun gear which meshes with a plurality of planetary gears, preferably three in number, one of which is shown at 22, and said planetary gears in turn mesh with an internal ring gear 23 secured to the casing section 6 in any suitable manner, as by means of screws 24.

Rotation of the flywheel 12 is transmitted by the train of gearing above described to the barrel 20, thereby causing rotation of the latter. Suitable means are provided for transmitting the rotation of the barrel 20 to a clutch jaw 25, which is adapted to be displaced axially to engage a corresponding clutch jaw 26 on the shaft (not shown) of the engine to be started. In the form shown, said means comprises a yieldable driving connection which includes a friction clutch of the multiple disc type positioned within the rotatable barrel member 20. A plurality of clutch discs 27, which are annular in form, are splined at their outer peripheries to the inner surface of the barrel 20, and the remaining clutch discs are splined at their inner peripheries to the outer surface of an interiorly threaded nut 28. The clutch discs are held between the closed end of barrel 20 and a flange 29 formed on the nut 28.

Means are provided for yieldingly maintaining the clutch discs in frictional engagement with one another, which means is preferably adjustable, whereby the amount of torque transmitted by the clutch may be varied. To this end, a plurality of coil springs are provided, one of which is shown at 30, which bear against the flange 29 and are held in position by means of pins 31 carried by the spacer ring 32. The tension of the springs may be adjusted by means of an adjusting nut 33 threaded in the open end of the barrel 20. A threaded shaft 34 is positioned within the interiorly threaded nut 28 and is adapted for rotary and longitudinal movement relative thereto. A stop nut 35 is threaded onto the outer or left end of the shaft 34, which is adapted to engage an interior shoulder in the nut 28 to limit the longitudinal movement of the screw-shaft 34 and a portion of the shaft adjacent its inner end, and is provided with longitudinal splines 36 which engage corresponding splines 37 formed on the interior of a hub portion 38 constituting an integral part of the clutch jaw 25. Coil spring 38 is interposed between the screw-shaft 34 and the clutch jaw 25, the outer extremity of said springs being preferably seated in a recess formed in the shaft.

Any suitable means may be utilized for axially displacing the clutch jaw 25 to engage the clutch jaw 26 of the engine, and in the form shown, a rod 40 is employed which passes concentrically through the hub 18, barrel 20, shaft 34, and clutch jaw 25, and is provided intermediate its ends with a shoulder 41 engaging the outer end of screw-shaft 34 and on its inner end with a nut 42 for securing the clutch jaw 25 thereto. Rod 40 is adapted to be displaced by suitable mechanism extending externally of the starter casing, such mechanism, constituting a part of the present invention, to be described hereinafter.

It is desirable to provide means whereby the engine may be cranked and started by hand and, in the present instance, said means embodies a hand-cranking shaft disposed substantially at right angles to the longitudinal axis of the starter and drivably connected with the reduction gearing near its low speed end. For this purpose, a bevel gear 43 is mounted on the end of shaft 19 and adapted to mesh with the bevel gear (not shown) that is carried in the usual manner on the hand-cranking shaft projecting outwardly from the starter casing, said cranking shaft being provided with a suitable hand-crank, whereby the bevel gear 43 and barrel 20 may be rotated through the train of gearing hereinbefore described.

Power means for cranking and accelerating the flywheel 11 are employed and, in the embodiment illustrated, comprise an electric motor 44 mounted in casing section 9 and having its armature shaft drivably connected to the flywheel 11 in any suitable manner, as by means of a clutch (not shown). Energization of the electric motor will produce rotation thereof and also of the flywheel 11 through the driving connection therebetween.

Means are provided for controlling the energization of the motor 44 and preferably comprise a remote control switch 45 which is adapted to be mounted on the dashboard of an automobile or the instrument panel of an aircraft, and include an insulating casing 46 having a cover-plate 47 which is adapted to be secured to the instrument panel in any suitable manner, and a control rod 48 arranged to be actuated by means of the knob 49. Binding posts 50 and 51 are provided for connecting the switch to a suitable source of electric current, such as a battery, and to a solenoid switch 52 (Fig. 1), binding post 50 being connected to ground by means of conductor lead 53, and binding post 51 being connected to the winding 54 of the solenoid switch 52 by means of a conductor 55; the other end of the solenoid 52 being arranged for connection to one side of the source of electric current by means of lead 56, and the opposite side of the source being grounded to provide a return to the binding post 50 through lead 53.

Closing of the circuit of the winding 54 may be accomplished by bridging a pair of spring contacts 57 and 58 located within casing 46 and connected to the binding posts 50 and 51, respectively. To this end a metallic disc 59 is secured to the rod 48 in any suitable manner, and is adapted to be interposed between the spring contacts 57 and 58 when the knob 49 is pushed inwardly against the tension of a coil spring 60 surrounding the rod 48 and interposed between the rear wall of the casing 46 and an insulating sleeve member 61. When the knob 49 is released, spring 60 causes the rod 48 to return to normal position, at which instant the circuit between contacts 57 and 58 is broken by the interposition

of the insulating sleeve member 61 therebetween.

Energization of the winding 54 of the solenoid switch 52 causes the attraction of the armature 62, which may be of some suitable magnetic material such as soft iron, and to which is secured an insulating rod 63 for actuation therewith. Attraction of the armature 62 causes the rod 63 to be moved to the left as viewed in Fig. 1, thereby closing a pair of contacts 64 and 65 (Fig. 5) by means of a bridging member 66 formed of suitable conducting material and secured to the rod 63. Upon de-energization of the winding 54, armature 62 is repelled therefrom by means of a coil spring 67 interposed between the bridging member 66 and terminal plate 68 of the solenoid switch 52. The solenoid switch 52, as shown in Fig. 1, may be secured to the casing section 9 of the starting mechanism in any suitable manner, as by means of bolts or screws (not shown).

Contact 65 of the solenoid switch is connected to one side of the electric motor by means of a conductor 69, the other side of the motor being grounded as indicated at 70 (Fig. 5); while contact 64 is connected to a source of electric current such as a battery 71, by means of the conductor 56, which also connects the winding 54 of the solenoid switch to said source.

It will be apparent that upon actuation of the knob 49 inwardly the contacts 57 and 58 will be bridged, thereby closing the circuit of the winding 54 and causing energization of the latter, whereupon the armature 62 will be attracted by the magneto motive force produced in the coil to cause closing of the contacts 64 and 65, and hence energization of motor 44.

It is desirable that the control of the electric motor and of the engine engaging member 25 be accomplished from a single control point, and to this end the rod 48 is provided with a hollow extending portion 72 (Fig. 2) which is secured to one end 73 of a bell-crank 74 by means of a connecting rod 75 provided with a pin and slot connection 76—77, whereby inward movement of the rod 48 does not produce any movement of the bell-crank 74 inasmuch as pin 76 will move in the slot 77, but upon an outward movement of the rod 48 pin 76 will engage the end of the hollow portion 72 of the rod, thereby actuating the bell-crank, as indicated in Fig. 2. Bell-crank 74 is pivotally mounted upon a boss 78 formed integrally with the intermediate casing section 7 and projecting upwardly therefrom. Rigidly secured to the fulcrum point of the bell-crank and movable with the latter is a rod 79 which extends through the boss 78 into the casing and is additionally supported by a member 80 formed integrally with the plate 10 interiorly of casing section 7. The other end of the rod 79 is provided with a toe portion 81 which engages one end of the actuating rod 40 by means of a pin 82 passing through the rod and said toe portion. It will be apparent that when the knob 49 is pulled outwardly the bell-crank 74 will be actuated by means of the connecting rod 75, thereby causing rotation of the rod 79 in the boss 78, and producing longitudinal movement of the actuating rod 40 to the right as viewed in Fig. 1 by means of toe portion 81.

A coil spring 83 encircles the rod 79 and one end thereof is secured to said rod while the other abuts the member 80, whereby the rod 79 is rotated back to the normal position when the knob 49 is released. A coil spring 84 may be interposed between the flange 59 and the cover-plate 47 for assisting spring 83 in returning knob 49 to normal position after it has been pulled outwardly.

It will be seen that longitudinal movement to the right of the actuating rod 40 will cause clutch jaw member 25 to engage the engine clutch jaw 26 to crank the latter when the energy stored in the flywheel 11 is imparted to clutch jaw 25 through the reduction gearing and the yielding driving connection including the disc clutch hereinbefore described.

It is also desirable that ignition current be supplied to the internal combustion engine to be started simultaneously with the cranking of the engine member 26, and to this end a novel auxiliary ignition supply device is provided which is adapted to be rendered operative at the instant that the clutch jaw member 25 is in engagement with the engine member 26 and inoperative after the engine is running under its own power, ignition current being supplied thereafter by any suitable means such as magnetos (not shown), for example. In the form shown, said device comprises an ignition coil of the usual type enclosed in a two-part casing formed in sections 85 and 86 secured together by means of screws 87, said casing being arranged for attachment in any suitable manner to the casing section 9 of the starter, as by means of a bracket 88, flange 89 on the ignition coil, casing section 85, and screws 90 and 91.

The ignition coil is of the usual interrupter type and is provided with primary and secondary windings 92 and 93, respectively, one end of the primary being connected to the battery 71 (Fig. 5) by means of a conductor 94 and the binding post 95, while the other end of said coil is connected to the movable contact 96 by means of a binding post 97 through spring armature 98. The circuit of the primary is completed through the fixed contact 99 and conducting plate 100 which is grounded to the casing section 85 by means of sleeve member 101 and binding post 102. One end of the secondary winding 93 is connected to that end of the primary which is connected to the movable contact 96, by means of an internal connection (not shown), while the other end of the secondary is provided with a conductor lead 103 for connection to the spark plugs of the engine being started, as indicated diagrammatically at 104 (Fig. 5).

The operation of the ignition coil is well known in the art and need not be described herein. Means, however, are provided for rendering said ignition coil operative at the instant that the rod 48 of the remote control switch 45 is pulled outwardly to cause meshing of the starter clutch jaw with the engine clutch jaw, and in the embodiment illustrated in Fig. 2 and more fully described and claimed in my divisional application filed May 20, 1933, and bearing Serial No. 672,063, said means comprise an insulating rod 105, one end of which normally abuts spring armature 98 by the action of a coil spring 106 to maintain the movable contact 96 out of engagement with the fixed contact 99, and the other end of which is secured to a connecting rod 107, the latter being arranged to be actuated against the tension of the spring 106 by a connection with the end 108 of the bell-crank 74, said connection including a spring 109, one end of which is connected to the bell-crank and the other to an internally threaded sleeve member 110 secured to the connecting rod 107.

From the foregoing arrangement it will be apparent that in the normal position contacts 96

and 99 will be open and hence the ignition coil will not be energized, but upon outward pulling of the knob 49 to cause meshing engagement between the starter and the engine by the actuation of the rod 79 through the bell-crank 74, the connecting rod 107 of the ignition coil will be pulled to the right as viewed in Fig. 2 by means of the connection thereof to the end 108 of the bell-crank, thereby permitting the spring armature 98 to move the contact 96 into engagement with contact 99, thus causing the energization of primary winding 92 of the coil in the usual manner.

The operation of the starting apparatus is as follows: When it is desired to start the internal combustion engine with which the starter is associated, knob 49 is first pushed inwardly to cause the energization of the motor 44 through the action of solenoid switch 52, whereby flywheel 11 is accelerated and brought up to speed. The knob 49 is held in the inward position until such time as the flywheel 11 has acquired the necessary speed, whereupon the knob is pulled outwardly to cause de-energization of the motor 44 and to impart longitudinal movement to the actuating rod 40 and meshing of clutch jaw members 25 and 26, thus imparting the energy stored in the flywheel to the engine to be started, for cranking the latter and simultaneously energizing the ignition coil through the bell-crank 74 and the connection therebetween, thus producing a shower of sparks in the cylinders of the engine at the instant that the pistons are actuated through the crank shaft and connection of the latter with the starter through the clutch jaws 25 and 26.

There is thus provided novel starting apparatus and control means therefor, whereby the acceleration of the inertia member or flywheel, the imparting of the energy stored in said flywheel to the engine to be started, and the supply of ignition current to said engine may be controlled in proper sequence from a single point. There is also included in the system a novel ignition coil which is adapted to be rendered operative simultaneously with the meshing of the starter and the engine, thereby eliminating a separate ignition switch.

The apparatus is simple in construction and arrangement of parts, which are relatively few, and requires only a single electro-mechanical control, which is adapted to be mounted within ready access of the operator for placing the apparatus into operation to start an engine.

While only one embodiment of the invention has been described and illustrated, various changes in construction, arrangement and substitution of parts, which will now appear to those skilled in the art, may be made without departing from the scope of the invention, and reference is therefore to be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In combination with engine starting apparatus of the type wherein a rotatable inertia member is first actuated in order to store energy therein and subsequently connected to a rotatable member of the engine to be started, means for rotating said inertia member to store energy therein, means including a normally open switch for supplying ignition current to the engine during starting, and means for electrically controlling said rotating means and mechanically holding the ignition current switch open, and means for connecting the inertia member to the engine member at the will of the operator and by the same action with drawing said holding means, whereby the stored energy and the ignition current are effective to start the engine.

2. In combination with engine starting apparatus of the type wherein a rotatable inertia member is first actuated in order to store energy therein and subsequently connected to a rotatable member of the engine to be started, means for rotating said inertia member to store energy therein, means for energizing said rotating means, means for connecting said inertia member with the engine to be started, means including a normally open switch for supplying ignition current to said engine during starting, and control means for electrically actuating said energizing means and for mechanically holding said ignition current switch normally open.

3. In combination with engine starting apparatus of the type wherein a rotatable inertia member is first actuated in order to store energy therein and subsequently connected to a rotatable member of the engine to be started, means for rotating said inertia member to store energy therein, magnetically actuated means for energizing said rotating means, means for connecting said inertia member with the engine to be started, means including a normally open switch for supplying ignition current to said engine during starting, and control means for electrically actuating said energizing means and having a mechanical connection for holding said ignition current switch normally open.

4. In combination with starting apparatus, for internal combustion engines, of the type wherein a rotatable inertia member is first actuated in order to store energy therein and subsequently connected to a rotatable member of the engine to be started, means for rotating said inertia member to store energy therein, electro-magnetically controlled means for energizing said rotating means, mechanically actuated means for connecting said inertia member with the member of the engine to be started, means for supplying ignition current to said engine during starting, and electro-mechanical control means for actuating said energizing means, said connecting means and said ignition current supply means.

5. In combination with starting apparatus, for internal combustion engines, of the type wherein a rotatable inertia member is first actuated in order to store energy therein and subsequently connected to a rotatable member of the engine to be started, electrical means for rotating said inertia member to store energy therein, electro-magnetically controlled means for energizing said rotating means, mechanically actuated means for connecting said inertia member with a member of the engine to be started, an auxiliary ignition coil for supplying current to said engine during starting, and electro-mechanical control means for actuating said energizing means and having a mechanical connection for simultaneously actuating said connecting means and rendering said ignition coil operative at the will of the operator, whereby the stored energy and the ignition current are rendered effective to start the engine.

6. In combination with engine starting apparatus of the type having a driving member adapted to be engaged with the crank shaft of the engine for the purpose of rotating the latter, means including a rotatable inertia member for actuating said driving member, means for rotating said inertia member to high speed for the

purpose of storing energy therein, means for supplying ignition current to said engine during starting, electro-magnetic means for energizing said rotating means, means for moving said driving member into engagement with the engine crank shaft, and electro-mechanical means remote from said apparatus for controlling the operation of said magnetic means, said ignition current supply means, and said means for moving said driving member into engagement with the engine crank shaft.

7. In combination with engine starting apparatus of the type wherein a rotatable inertia member is first actuated in order to store energy therein and subsequently drivably connected to a rotatable member of the engine to be started, electrical means for storing energy in said inertia member, a source of current supply for said electrical means, means adapted to be energized from said source for supplying ignition current to said engine during starting, means for controlling the flow of current from said source to said electrical means and for effecting a driving connection between the inertia member and the engine member and for rendering said ignition current supply means operative, including a solenoid winding and switch means for controlling the flow of current to said winding and having a mechanical connection with said inertia member and said ignition current supply means.

8. In an engine starter, in combination with a member of the engine to be started, a member movable to engage and crank said engine member, driving means for said engine engaging member including a rotatable inertia member in which energy is stored prior to movement of said engine engaging member to cranking position, means for rotating said inertia member to store energy therein, auxiliary means adapted to be energized from a source of electrical energy for facilitating starting of the engine, and mechanical means for jointly operating said engine engaging member and auxiliary means, said mechanical means including a part controlling the energization of said rotating means.

9. In an engine starter, in combination with a member of the engine to be started, a member movable to engage and crank said engine member, driving means for said engine engaging member including a rotatable inertia member in which energy is stored prior to movement of said engine engaging member to cranking position, an electric motor for rotating said inertia member to store energy therein, a motor energizing circuit having a normally open switch therein, auxiliary means adapted to be energized from a source of electrical energy for facilitating starting of the engine, and mechanical means for jointly operating said engine engaging member and auxiliary means, said mechanical means including a part controlling the closure of said switch.

10. In an engine starter, in combination with a member of the engine to be started, a member movable to engage and crank said engine member, driving means for said engine engaging member including an inertia member and an electric motor for energizing said inertia member prior to movement of said engine engaging member to engine engaging position, a motor energizing circuit, electro-magnetic means for closing said circuit, and means for preventing movement of said engine engaging member to engine engaging position while said electro-magnetic means remains energized, said last-named means including a switch controlling the energization of said electro-magnetic means, a linkage for operating both said switch and engine engaging member, and resilient means tending to resist movement of said linkage.

11. In a starting means for internal combustion engines, the combination of a power starter, a set of ignition controlling contacts, means for energizing the starter, means normally holding said contacts apart and common means for simultaneously connecting said energized starter in operative relation with the engine and withdrawing said holding means.

12. In a starting means for internal combustion engines the combination of an inertia starter, a motor for energizing the same, and a starting ignition generating means, said means including an ignition switch locking member with means connected with the motor and the starter for first starting the motor and energizing the inertia starter without affecting the starting ignition generating means, and means connected with the starter and the starting ignition for then simultaneously connecting the energized starter with the engine and withdrawing said switch locking member.

13. In a starting means for internal combustion engines the combination of a power starter of the inertia type, an electric motor for energizing the same, an ignition power generating system including an ignition switch locking member and common means for simultaneously connecting the starter in operative relation with the engine and withdrawing said switch locking member including means for controlling the electric motor prior to connecting the starter with the engine.

14. In a starting means for internal combustion engines the combination of an inertia starter, a motor for energizing the same, and a starting ignition generating means, said means including an ignition switch locking member with means connected with the starter, the motor and the generating means for first starting the motor and energizing the inertia starter, without affecting said switch locking member and then simultaneously connecting the energized starter with the engine and controlling the starting ignition, said means including a shaft member and instrumentalities whereby when the shaft is given one movement the motor is started to energize the starter and when given another and different movement the starter is connected with the engine and simultaneously therewith the switch locking member is withdrawn.

JOSEPH W. ALLEN.