A. D. T. LIBBY.

STARTING MECHANISM FOR HYDROCARBON ENGINES.

APPLICATION FILED APR. 12, 1913.

1,219,569.

Patented Mar. 20, 1917.

6 SHEETS—SHEET 1.

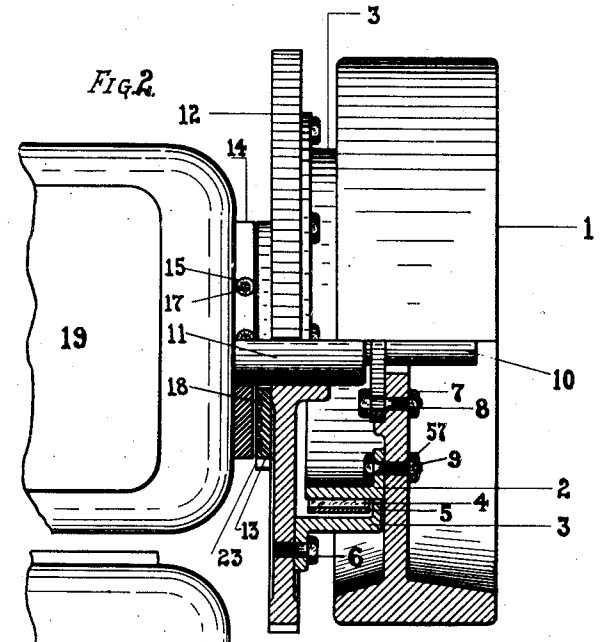


FIG. 2.

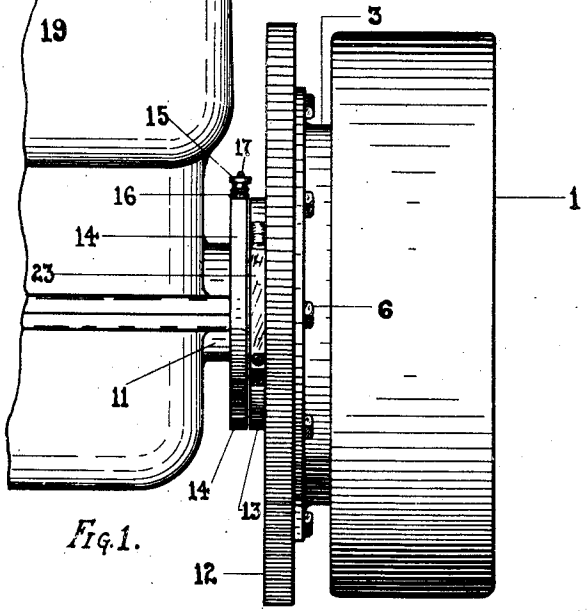


FIG. 1.

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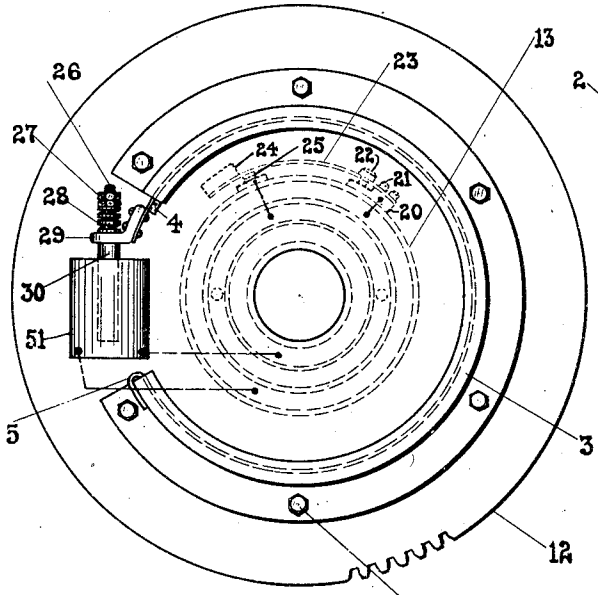


FIG. 3.

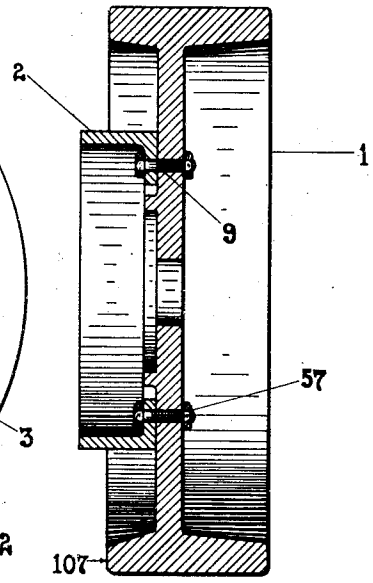


FIG. 4.

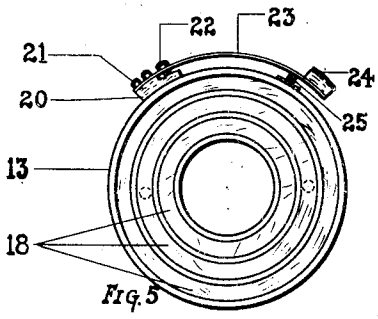


FIG. 5.

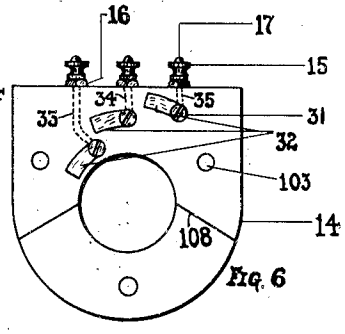


FIG. 6.

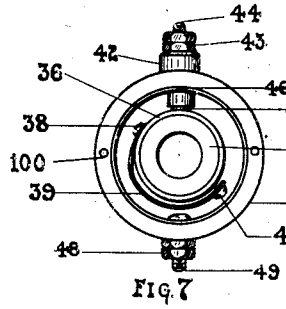


FIG. 7.

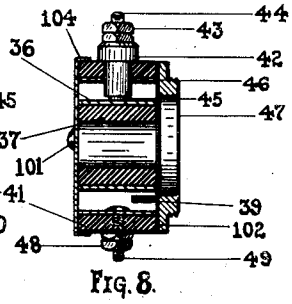


FIG. 8.

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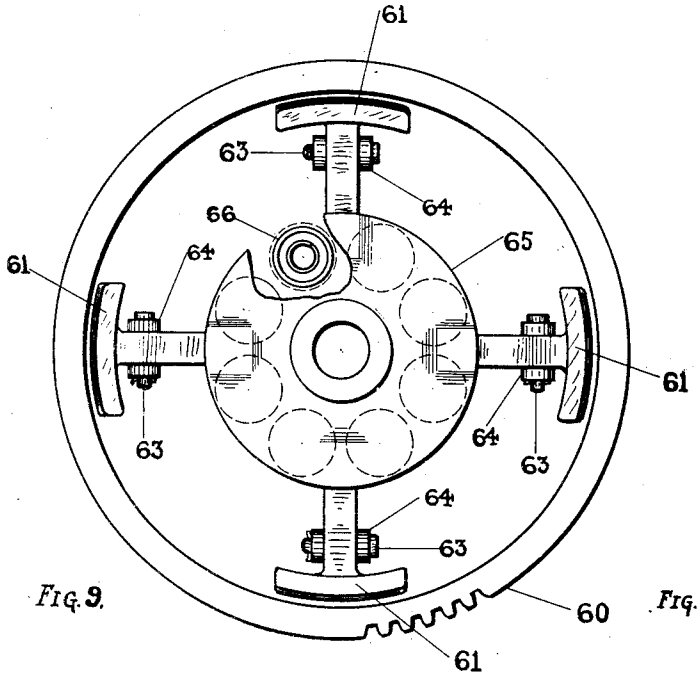


Fig. 9.

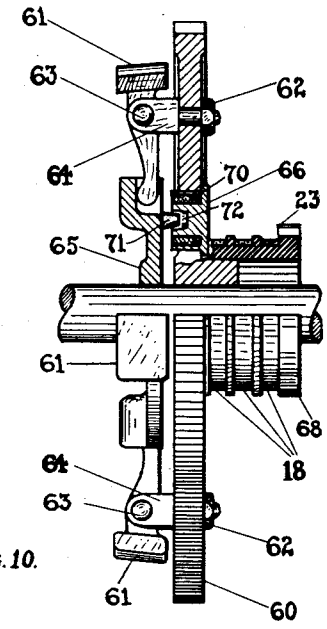


Fig. 10.

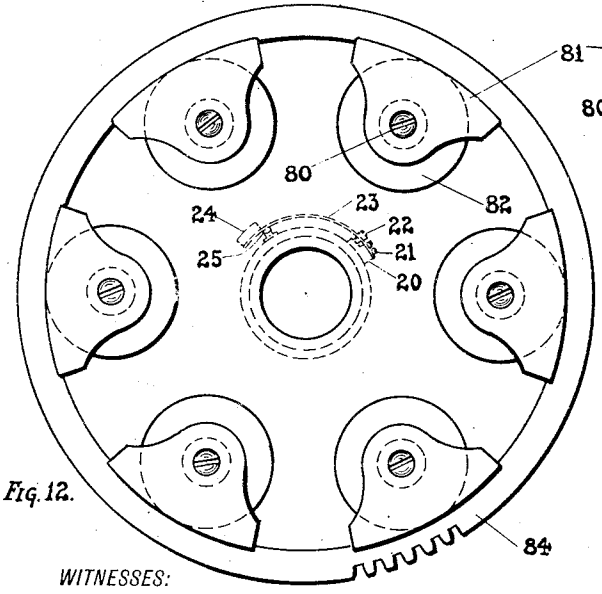


Fig. 12.

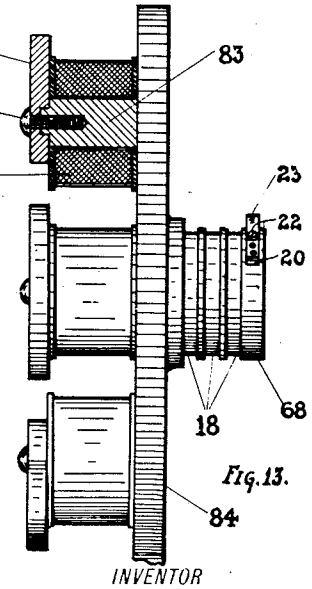


Fig. 13.

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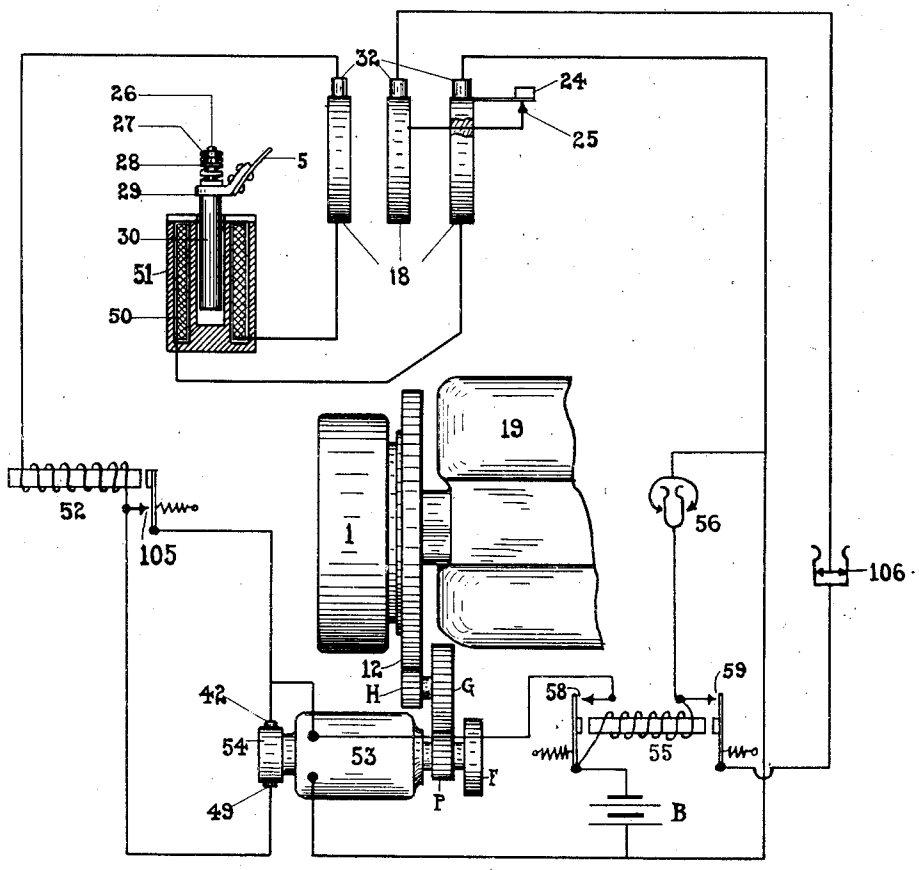


FIG. 11.

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6 SHEETS—SHEET 5.

FIG. 14

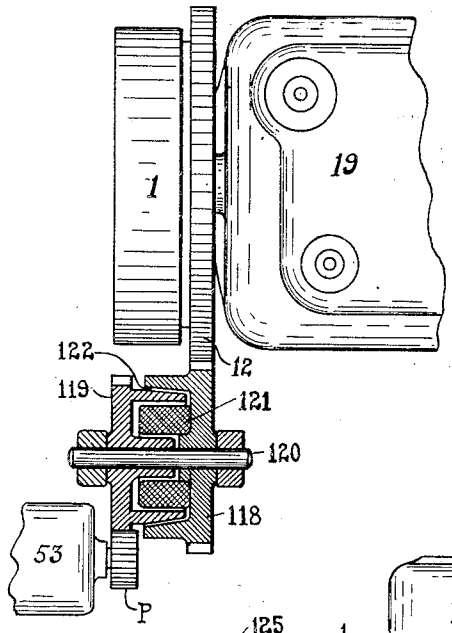
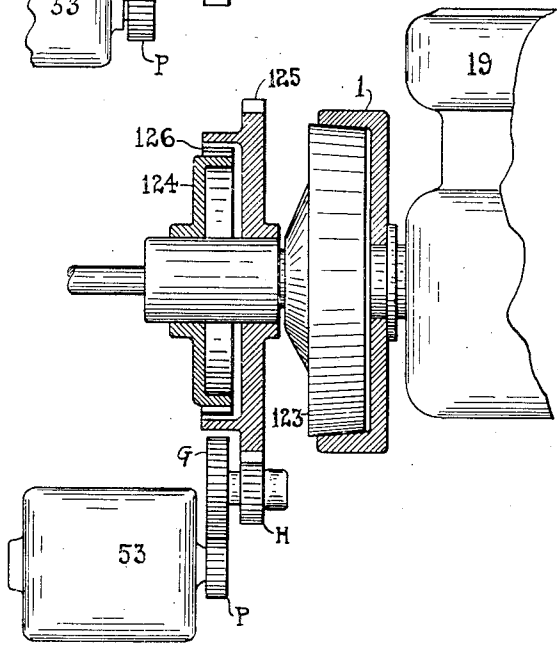


FIG. 15



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6 SHEETS—SHEET 6.

FIG. 17

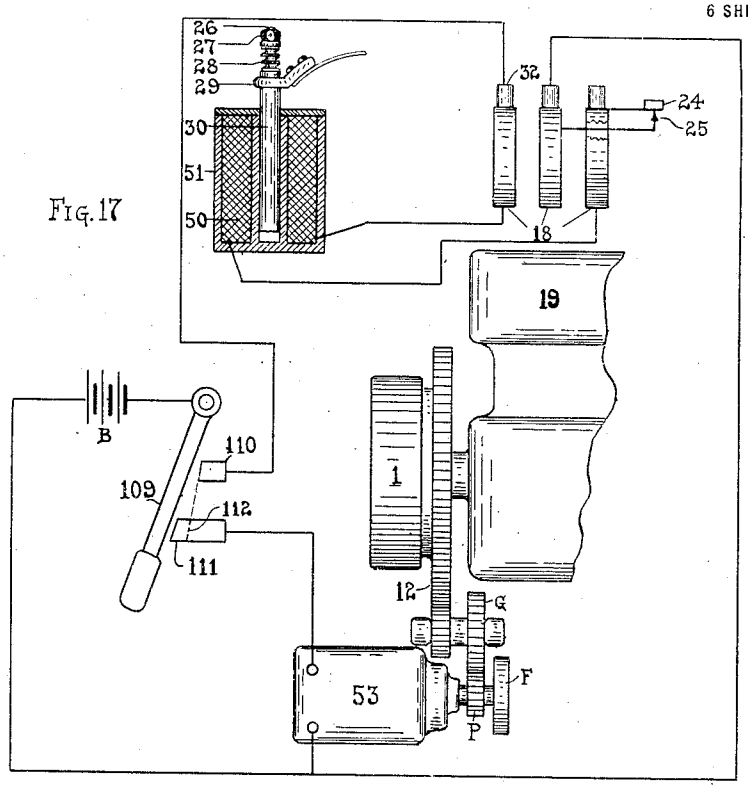
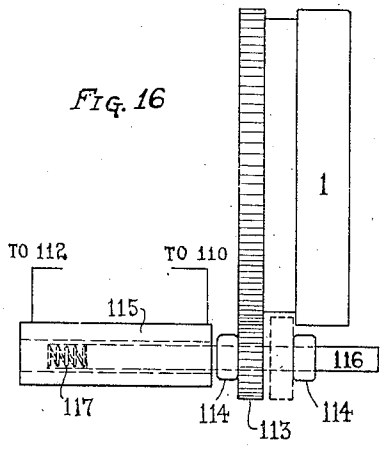


FIG. 16



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UNITED STATES PATENT OFFICE.

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STARTING MECHANISM FOR HYDROCARBON-ENGINES.

1,219,569. Specification of Letters Patent. Patented Mar. 20, 1917.

Application filed April 12, 1913. Serial No. 760,842.

To all whom it may concern:

Be it known that I, ALBION D. T. LIBBY, a citizen of the United States, resident of Orange, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Starting Mechanisms for Hydrocarbon-Engines, of which the following is a specification.

My improvement relates to the means of starting a hydrocarbon, or internal combustion engine, and as illustrated in the drawings accompanying this specification, relates more particularly to an engine used in an automobile. I do not wish, however, to be limited to the use of my improvements, to an automobile, as they may be applied to any type of engine, which it is desired to start in a simple and expeditious manner. In the early types of automobiles, and in some that are being made today, the engine is started by means of a crank at the front end of the car, but in order to make it easier and more convenient, certain mechanisms have been applied to the engine in such a manner that the same can be started from the driver's seat by pushing down on a pedal with the foot, which act engages the pinion with a gear cut, on or attached to the fly wheel of the engine, at the same time, closing the battery circuit through the windings of the motor. The great objections to starters of this nature, is, that they take an excessive amount of current from the battery used for this purpose, both at the instant of closing the switch, and subsequently during the operation of cranking the engine, as they start at a slow speed, under a dead load, and this load has to be carried until the speed increases, to such a point as will cause the ignition apparatus to work, and the engine then runs from its own fuel.

These types of starters are also subject to difficulties of meshing the pinion with the gear on the fly wheel, and the consequent danger of stripping teeth from the gears. Considerable strength is also required in many cases to engage the pinion with the fly wheel gear against the action of the spring, which must be stiff enough to throw out the pinion, when the foot pressure is released from the pedal, thus making the operation hard for lady drivers, for whom the engine starting devices are a special boon.

By my improvement, I start the motor under "no load," or, at least, a very light load, due only to the inertia of the gear set, and a small fly wheel mounted on the end of the motor shaft. When the motor attains approximately its maximum speed, or any predetermined speed, the gear set is then engaged, and likewise the motor, which is connected to the gear set, with the engine. As shown in the drawings, this engagement takes place through the medium of the fly wheel, yet, I do not wish to be limited to this precise manner. By this method of operation, I reduce the power consumption taken from the battery to a minimum, and begin to turn the engine over at a maximum speed right from the start instead of turning it at a minimum speed, and then bringing it up to the speed of ignition, as in methods now in vogue. By cranking the engine in this manner, at its maximum speed on the start, the ignition devices are in a condition to operate at once, and the engine begins to fire its charges with the least possible delay. My improvements are illustrated in the following drawings, in which like characters are used, to represent corresponding parts in the various figures.

Figure 1 is a side elevation, showing a portion of one of the engine cylinders on the left, and the fly wheel to the right, between the two of which, a portion of the gear set, and other mechanism, is mounted.

Fig. 2 is a plan view of Fig. 1, with a portion of the fly wheel and starting mechanism in section.

Fig. 3 shows the preferred form of one element of the gear set carrying the clutching mechanism, which engages the engine through the medium of the fly wheel.

Fig. 4 shows the fly wheel in section with the member attached thereto, which is engaged by the mechanism shown in Fig. 3.

Fig. 5 illustrates a controller and slip rings used in connection with the mechanism shown in Fig. 3.

Fig. 6 is a connecting block mounted on the engine frame, and which serves to carry the electric current to the slip rings shown in Fig. 5.

Fig. 7 is a controller used on the end of the starting motor shown in Fig. 11. The cover of this controller is removed to show the interior mechanism.

Fig. 8 is a cross section of Fig. 7, showing more in detail, the parts used in connection therewith.

Fig. 9 is a modified form of clutch used to connect the gear set with the fly wheel.

Fig. 10 illustrates a part section and end elevation of Fig. 9.

Fig. 12 shows another modified form of attaching the gear set to the fly wheel, while Fig. 13 is an end elevation of Fig. 12, one coil and pole shoe being in section, Fig. 11 is a simple diagram of the parts involved in the electrical circuits.

Fig. 14 is a modified form of my invention in which the magnetic clutch is incorporated in the gear set.

Fig. 15 is another modified form in which the automatic clutch is incorporated as a part of the regular clutch.

Fig. 16 is a still another modified form in which gear teeth are cut on, or attached to the fly wheel and the starting motor is adapted to be connected thereto by magnetic means acting on a sliding pinion.

Fig. 17 is a simplified form of Fig. 11 in which manual control means are used instead of automatic devices.

Referring now to the details, 1 represents the fly wheel of the engine, to which is attached a flange 2, which as shown, is held thereto by means of the bolts 9 and nuts 57, although this flange may be made integral with the web of the fly wheel.

Mounted in any suitable manner on the engine frame is a gear wheel, 12, to which is attached a flange 3. In the drawings, this flange is shown attached to the gear wheel by means of bolts 6, although it may be made integral. Carried by this flange, is a resilient member 5, commonly known as a brake band, the inner surface of which is lined with a friction material 4, which may be of leather, raybestos, or other suitable material. One end of this brake band is secured to the flange 3, while the other, or, free end, is attached to a lug 29, shown in Fig. 3, and this lug is associated with a plunger 30, of a solenoid 51, supplied with a suitable winding 50. The movement of the plunger, and likewise, the tension on the brake band, is regulated by means of spring 28, and nuts 27, mounted on the threaded extension 26, of the plunger 30.

Also mounted on the gear wheel 12, is a set of slip rings, 18, shown in Fig. 5. These rings are mounted on a suitable insulating block, and the whole attached to the gear wheel in any suitable manner, such as by two screws shown in dotted lines, these screws being set into the insulating material, below and out of contact with the slip rings. One pair of these slip rings is connected to the winding 50, of the solenoid. One of the rings of the pair above referred to, is connected to a block 20, which is attached to the slip ring block 13, by means of screws 21. Mounted on block 20, is a resilient member 23, which can be adjusted by an adjusting screw 22. On the end of this resilient member 23, is a weight 24. To the third slip ring is connected an insulated contact 25, which is mounted on the exterior surface of the block 13. The pressure on the contact 25, can be adjusted by means of the screw 22, and this adjustment is so made that the contact 25 is opened, when the speed of rotation of the wheel 12, reaches a certain predetermined point, at which speed the weight 24 is thrown outward, opening the contact at 25. The electrical circuit connections are carried to the slip rings through the medium of the brushes 32, which are mounted on the block 14, as shown in Fig. 6. These brushes are connected by the connectors 33, 34 and 35, to their respective binding posts 17, which are locked in place by the nuts 16, and connections may be made thereto by clamping the terminals under the nuts 15. The block 14 is held to the engine frame by screws passing through the holes 103. This block is made so that it can be readily removed for inspection if necessary, it being divided along the lines 108. The gear wheel 12, and the fly wheel 1 are so related in position, that the brake band 5 encircles the flange 2 on the fly wheel, so that when current is passed through the winding 50, of the solenoid 51, the brake band is drawn down and clutches the flange 2.

The controller, or governor, 54, mounted on the motor 53 and shown in Figs. 7 and 8, has a flange 47, which is attached to the end of the bearing of the motor in any suitable manner, it being shown threaded, and attached to this flange are insulating members 41 and 102. Through 41 passes a brush holder of insulating material 42, said holder carrying the brush 45, connections being made to the holder by the nuts 43 on the stem 44. The brush 45 runs on a metal ring 36, which is carried on another insulating member 37, the member 37 being attached to and rotated by the shaft of the motor. Attached to ring 36, by a screw or other means, 38, is a resilient member 39, on the end of which is a contact point 40. On the interior wall of the ring 41, is a metallic ring 46. Attached to this ring is a metallic stud 49. The resilient member 39 is adapted to be thrown outward from the center, as the motor rotates, until the contact 40 engages the metallic ring 46, at which time an electrical circuit is completed from the stud 44 through to stud 49.

In one of the modified forms of my invention, shown in Figs. 9 and 10, the engagement is made with a fly wheel by means of the members 61, which are carried on studs 64, the same being fastened to the gear wheel 60 by nuts 62, the members 61 being pivoted at 63. The members 61 may be faced with friction material, and are adapted to engage the inner surface of the

fly wheel. When this form is used, the flange 2, shown in Fig. 4 is not needed. Mounted on the gear wheel 60, is a number of small electromagnets 66, the number required, depending on the pull that is desired. These magnets are wired to suit the case, and are connected to the slip rings 18, which are carried by the member 68, in a similar manner as the rings 18 of Fig. 5. Mounted on the shaft, is a member 65, which is free to slide back and forth. This member has projections 71, which project into the recesses 72 of the core of the magnets 66, on which are wound coils 70. When these coils are energized, member 65 is drawn toward the gear wheel 60, and the members 61, are rotated about the pivot 63, until their faces engage the rim of the fly wheel. This engagement takes place before the member 65 reaches the end of its movement, so that the fly wheel is gripped securely by the members 61, and is caused to rotate with the gear wheel 60. A similar controller or governor, as shown in Fig. 3, is mounted on the block 68, the spring of which is shown at 23.

In another modified form of my invention, shown in Figs. 12 and 13, the gear wheel 84 is provided with core projections 83, on which are mounted coils 82, and attached to the cores by screws or bolts 80, are pole shoes 81. These pole shoes engage the rim of the fly wheel at 107, when the coils become energized, as the entire wheel 84 is loosely mounted, so that when the coils 82 are energized, it is drawn toward the fly wheel, the small pinion engaging the teeth on the gear wheel 84, being made longer than the face of the said gear wheel, to allow for this slight movement. Mounted on the gear wheel are slip rings, 18, similar to those shown in Fig. 10. The governor mechanism is also mounted on the same mounting block along with the slip rings. When the arrangement of Fig. 12 is used, the rim 107 of the fly wheel may have inserts of non-magnetic material of the proper circumferential length properly spaced apart so the pole shoes 81 will give the maximum pull, greater than if they engaged a continuous ring of magnetic material such as shown at 107.

Considering now, the general operation of my system, and referring particularly to Fig. 11, the push button 56, is mounted on the dash board, or in any convenient place, on the vehicle, and in order to start the engine, this button is pushed in and then released. The act of pushing in the button allows current to flow from the battery through the relay winding 55, which energizes the core, drawing up the armatures and closing the contacts 58, and 59. The closing of the contact 58 supplies battery current to the electric motor 53. The detail connections of the inside of the motor are so well known, that they are not described herein, the binding posts only, being shown on the top of the motor. The closure of the contact 59, allows the battery current to flow through the winding 55, of the relay, and by means of one of the brushes 32, and slip ring 18, through the contact 25, of the governor device on the gear wheel 12, back to the other side of the battery, thus locking the relay in its operated position. As soon as the current goes through the electric motor, this immediately starts and comes rapidly up to its maximum speed. At any predetermined point near this maximum speed, the automatic governor 54 operates by throwing out the spring 39, so that the contact 40 engages the ring 46, thus allowing the current to flow from the brush 42 through the governor to the stud 49, and through the relay device 52 to one of the brushes 32, and slip rings 18, through the coil 50 of the solenoid 51, to the outer slip ring 18, back to the other side of the battery. This flow of current through the relay device 52, attracts its armature. The relay device is locked in position through the contact 105, so that as the speed of the motor diminishes after the load is thrown on, the current through the solenoid winding will not be interrupted. At the instant the current passes through the solenoid winding 50, the plunger 30 is attracted, and the brake band 5 is drawn together, bringing the friction surface 4 into engagement with the flange 2 on the fly wheel.

As has been hitherto described, the plunger 30 is made to be readily adjustable, so that the clutch can be increased or diminished in tension, as desired. During the interval, from the time the current is closed on the motor until the clutch acts, a large amount of energy is stored up in the fly wheel "F", and at the instant the clutch seizes the fly wheel, or other part of the engine which it is designed to engage, the shock of the engagement is absorbed by the energy of the fly wheel "F", so that the motor does not draw any greater amount of current for some little interval of time, and the engine is turned over at its maximum speed, immediately. Should, for any reason, the ignition devices fail to operate at once, the entire combination will keep on turning, and as the energy of the fly wheel "F" is absorbed, in doing work on the engine, its speed, and the speed of the motor will decrease, and the motor will begin to draw more and more current until it reaches a certain value, and it will continue turning the engine at this stated amount of current until the driver sees that something is wrong and desires to shut off the power, which he can do by pushing the button 106, which breaks the locking circuit on relay 55 and consequently cutting off the current to the motor, relay 52 and the clutch.

Assuming however, that the engine fires immediately, it will at once pick up in speed much faster than the motor 53 has been turning it, and as soon as it increases in speed to a predetermined point, the governor weight 24 is thrown outward, and the contact 25 is opened, thereby breaking the lock through the winding of the relay 55, thereby cutting the current off the motor, the relay device 52, and the clutch. It is thus seen that the system as described is entirely automatic, merely necessitating the pushing in of a small button, which can be mounted in any convenient place on the vehicle.

While I have shown and described an automatic system, yet, I do not wish to be limited to the exact forms shown, as it is perfectly feasible to perform certain of the automatic features manually. For example, I may use a manual controlling switch which in its first position, may throw current on to the motor, and in its next position, close a circuit through the clutch, thus dispensing with the relays 52 and 55, and push buttons 56 and 106. In this case, the operator will cut the current off by the switch, immediately the engine starts, although no harm will result, even though the current be kept on. I arrange and adjust the preferred form of my invention so the engine tends to run away from the clutch, when the speed of the engine becomes faster than the gear set. I may also close the clutch winding at the instant of applying current to the motor, and start from on "dead load", or, I may use a magnetic means of engaging a gear cut, on, or attached to a fly wheel with a sliding pinion, doing so at the instant of starting, and I may also incorporate the magnetic clutch within the gear set, connecting one side of the clutch member to the engine, letting it run idle with the engine, when the starter is not in use. I may incorporate my automatic clutch as a part of the regular clutch, especially where the regular clutch is of the cone type, in which case the cone clutch is released from the engine in the usual manner, until the starting motor is up to speed, when the cone clutch is released and engages the engine fly wheel.

I will briefly describe these modifications.

In Fig. 14, 19 illustrates a portion of the engine 1, the fly wheel. 12 is a large gear wheel, the same as shown in Figs. 1 and 2, but in this case, it is fastened securely to the fly wheel 1 and rotates with it. The starting motor 53 is connected by means of a pinion, P, to a gear wheel 119, which is carried on a suitable shaft 120. Mounted also on shaft 120 is another gear wheel 118. Gear wheels 118 and 119 are so constructed that in a space between them there is mounted a coil 121, and when the motor 53 reaches a certain predetermined speed, the circuit is closed through the coil 121 in the same manner as has been described in the operation of the apparatus shown in Fig. 11. As soon as current passes through the coil 121, the gear wheel 119 is drawn toward the gear wheel 118 and they engage along the surface 122, thereby forming a magnetic lock, and the gear wheel 118 is then carried along with 119, and movement is transmitted to the engine through the gear wheel 12. When the engine "picks up" from its own power the circuit through the coil 121 is opened in a similar manner as described in Fig. 11.

In Fig. 15, the automatic clutching elements consist of gear wheel 125, brake band 126 and member 124 arranged in a somewhat similar manner as shown in Figs. 1, 2 and 3. In the operation of this modified form, the regular engine clutch 123 is released from the fly wheel 1 before the current is applied to the starting motor 53. As soon as the motor 53 reaches a certain speed, the clutch members 124, 125 and 126 are locked together in a manner previously described and then the clutch 123 is gradually released to its normal position into engagement with the fly wheel 1, and this immediately starts the engine turning over. Disconnection is made in the manner already described. In the modified form shown in Fig. 16, the starting motor 53 with intermediate gears is not shown. The pinion 113 which engages the gear teeth cut on or attached to the fly wheel, is normally in the position shown in dotted lines, and is carried on a shaft 116, supported by bearings 114. Around the shaft 116 is mounted a suitable coil with wires running to the switch points 110 and 112, as shown in Fig. 17, so that when the circuit from the battery B is closed across these two points, the solenoid is operated and the small gear wheel 113 is drawn into engagement with the gear teeth on the fly wheel. When the switch points 110 and 112 are separated the spring 117 returns the small gear 113 to its normal position.

Fig. 17 is a simplified form of Fig. 11 in which the relays 52 and 55, and switches 56 and 106 are disposed with and a special switch is used, consisting of two contact points 110 and 111 and switch blade 109. In the operation of the apparatus shown in Fig. 17, the switch blade 109 is thrown to the right. It first makes contact at 111 with an extended post. This first contact closes the circuit from battery B through the motor 53 and allows the motor to speed up. Continuing, the movement of the switch blade allows current to pass through the coil 50, which operates the clutch shown in Fig. 3. The automatic governor shown

in Fig. 5 is used to release the clutch when the engine "picks up." This governor may be dispensed with and the circuit opened by means of the switch blade 109 at the time of removing current from the starting motor. Should it be desired to close the current in the clutch coil at the same instant of starting, the long contact 111 may be reduced in length to the dotted line 112, and when so constructed, a circuit is closed through the clutch simultaneously with the starting of the motor.

The form of controller and method of making connection thereto may be greatly altered from those shown. It is thus easily seen that numerous and extensive changes and alternations may be made in the various devices, without departing from the spirit of my invention and the scope of the appended claims.

Having thus described my invention, what I claim, is:

1. In a device of the class described, the combination of an internal combustion motor, a fly wheel connected thereto, a flange on said fly wheel, a gear wheel having a flange thereon, gripping mechanism carried by said gear wheel, an electric motor connected to said gear wheel, and a source of power for the motor, means for connecting said source of power to said motor, and means independent of the current through said electric motor for operating said gripping mechanism, whereby the flange on said fly wheel is gripped by the gripping mechanism, and the combustion motor is caused to rotate, substantially as described.

2. In a device of the class described, the combination of an internal combustion motor, a fly wheel connected thereto, a gear wheel independently mounted thereon, means carried by said gear wheel for engaging said fly wheel, at a predetermined speed of said gear wheel, an electric motor connected to said gear wheel, and a source of power for said motor, means for connecting said source of power to said motor, means independent of the current through said electric motor for operating said first mentioned means, whereby the said fly wheel is engaged with said gear wheel and turned with it, substantially as described.

3. In a device of the class described, the combination of an internal combustion engine, a fly wheel attached to the main shaft thereof, a gear wheel mounted on said engine adjacent to said fly wheel, means carried by said gear wheel for engaging said fly wheel, an electric motor connected to said gear wheel, a source of electric current and means of applying same to the electric motor, automatic means carried on said motor and independent of its windings for conveying electric current to the first mentioned means carried by the gear wheel, whereby said means is operated to cause the gear wheel and fly wheel to engage and rotate together.

4. In a device of the class described, the combination of an internal combustion engine, a fly wheel attached to the main shaft thereof, a gear wheel independently mounted on said engine, and adjacent to the fly wheel, means including an electromagnet, carried by the gear wheel for engaging the fly wheel, an electric motor connected to said gear wheel, a source of electric current and means of applying same to said motor, governor mechanism carried by said motor and adapted to close an electrical contact at a predetermined speed, said electrical contact being in circuit with the electromagnet carried by said gear wheel, whereby when the electrical contact is closed, the electromagnet is energized, and the said engaging means is operated to cause the fly wheel to rotate with the gear wheel, substantially as described.

5. In a device of the class described, the combination of an internal combustion engine, a fly wheel attached to the main shaft of the engine, and having a flange thereon, a gear wheel independently mounted on said engine and adjacent to said fly wheel, an electromagnet, and a brake band carried by said gear wheel, an electric motor connected to said gear wheel, a source of electric current and means for applying same to the motor, governing mechanism carried by said motor, said governing mechanism being adapted to close an electrical circuit through the said electromagnet at a predetermined speed, whereby the same is operated and the brake band engages the flange on said fly wheel, causing the same to rotate with the gear wheel, substantially as described.

6. In a device of the class described, the combination of an internal combustion engine, a fly wheel attached to the main shaft thereof, a gear wheel mounted on said engine and adjacent to said fly wheel, means carried by said gear wheel for engaging said fly wheel, an electrical motor connected to said gear wheel, a source of electric current and means of applying the same to the motor, automatic means mounted on said motor for supplying current to the first mentioned means, and a second automatic means, independent of the motor, for supplying current to the first mentioned means, both said means being operated at a predetermined speed to operate the first mentioned means, whereby the gear wheel and fly wheel are engaged and the latter is caused to rotate with the former.

7. In a device of the class described, the combination of an internal combustion engine, a fly wheel attached to the main shaft

thereof, a gear wheel mounted on said engine and adjacent to said fly wheel, means carried by said gear wheel for engaging said fly wheel, an electric motor connected to said gear wheel, a source of electric current and means of applying the same to the motor, automatic means operated by said motor for connecting the source of electric current to the first mentioned means, a second automatic means operated by the first automatic means for maintaining the connecting of the source of electric current to the first mentioned means, substantially as and for the purpose described.

8. In a device of the class described, the combination of an internal combustion engine, a fly wheel attached to the main shaft thereof, a gear wheel independently mounted on said engine adjacent to the fly wheel, means carried by said gear wheel for causing the same to engage with the fly wheel, an electric motor permanently connected to said gear wheel, a source of electric current and means of applying same to the motor, controlling means operated by said motor, said controlling means operating a second controlling means whereby the influence of the first controlling means is removed, both said controlling means serving to control the first mentioned means, whereby the gear wheel and fly wheel are caused to engage and rotate together, substantially as described.

9. In a device of the class described, the combination of an internal combustion engine, a fly wheel attached to the main shaft thereof, a gear wheel independently mounted on said engine adjacent to the fly wheel, means carried by said gear wheel for clutching the fly wheel of the engine when the gear wheel is revolved at a predetermined maximum speed, an electric motor, a source of current and means to apply said source to said motor, controlling means operated by said motor at approximately its maximum speed, to control the first mentioned means, whereby the fly wheel of the engine is clutched and rotated, substantially as described.

10. In a device of the class described, the combination of an internal combustion engine, a fly wheel attached to the main shaft thereof, a gear wheel independently mounted on said engine adjacent to the fly wheel, means carried by the gear wheel for clutching the fly wheel of the engine when the gear wheel is revolved at a predetermined maximum speed, circuit controlling means carried by the gear wheel, an electric motor, a source of current and means of applying said source of current to said motor, said latter means being controlled by the circuit controlling means on the gear wheel, substantially as, and for the purpose described.

11. In a device of the class described the combination of an internal combustion engine, a fly wheel attached to the main shaft thereof, a gear wheel mounted on said engine, adjacent to said fly wheel, clutching mechanism carried by said gear wheel, said clutching mechanism being operated by an electromagnet or electromagnets, said electromagnet or electromagnets being excited by current controlled by a controller on said gear wheel, a source of current, an electric motor, and a circuit therefor, said motor being connected to said gear wheel, a controller carried by said motor and adapted to supply current to said electro-magnet or electromagnets at a predetermined speed, said first controller operating at a second predetermined speed to cut off the supply of current, substantially as and for the purpose described.

12. In combination, an internal combustion engine, a fly wheel, a reducing gear set permanently in mesh, a motor connected to said gear set, a source of power for said motor and means of applying same thereto and automatic means controlled by said motor for connecting said gear set to said engine only after said motor has attained to a certain predetermined speed, substantially as described.

13. In combination, an internal combustion engine having a fly-wheel with a flange attached thereto, a reducing gear set permanently in mesh, a motor connected to said gear set, a source of power for said motor and means for applying the same to said motor, a solenoid carried by an element of the gear set, a brake-band operated by said solenoid to clutch said flange whereby said engine is started, and automatic means carried by said element for disconnecting itself from said engine at a predetermined speed.

14. In combination, an internal combustion engine, a fly wheel, a reducing gear set permanently in mesh, a motor connected thereto, a source of power and means of applying same to said motor, automatic means controlled by said motor for connecting said gear set to said fly wheel only after said motor has attained a certain predetermined speed and automatic means controlled by said engine for releasing said gear set therefrom, substantially as described.

15. In combination, an internal combustion engine, a fly wheel, a reducing gear set, permanently in mesh, a motor connected thereto, a source of power and means of applying same to said motor, electromagnetic means controlled by said motor for connecting said gear set to said fly wheel only after said motor has attained a certain predetermined speed and automatic means controlled by said engine for releasing said gear set therefrom, substantially as described.

16. In combination, an internal combus-

tion engine, a fly wheel, a reducing gear set permanently in mesh, a motor connected thereto, a source of electric current and means of applying same to said motor, automatic means controlled by said motor for connecting the gear set to said fly wheel at a predetermined maximum speed substantially as described.

17. In combination, an internal combustion engine, a fly wheel, a reducing gear set permanently in mesh, a motor connected to said gear set, a source of electric current and means of applying same to said motor, controlling means operated by said motor at a predetermined maximum speed, and means carried by said gear set for disabling the said controlling means, whereby the gear set is disconnected from the engine, substantially as described.

18. In combination, an internal combustion engine, a fly wheel, a reducing gear set, permanently in mesh, a motor connected thereto, a source of current and means for applying same to said motor, a controller on the gear set controlling said means, a controller carried by said motor for automatically connecting the gear set to said fly wheel, said first named controller being controlled by the speed of the engine and operating to disable said means, whereby the gear set is released from said fly wheel, substantially as described.

19. In combination, an internal combustion engine, a fly wheel, a reducing gear set adjacent thereto, and permanently in mesh, an electric motor connected thereto, a source of electric current and means of applying the current to the motor, means controlled by said motor for connecting said gear set and motor to said fly wheel and means carried by said motor for absorbing the initial strain at the instant of said connection.

20. In combination, an internal combustion engine, a fly wheel, a reducing gear set adjacent thereto and permanently in mesh, an electric motor connected thereto, a source of electric current and means of applying the current to the motor, means controlled by said motor for connecting the gear set and motor to the engine at the maximum speed of the motor, and an inertia device on said motor shaft to absorb the strain at the instant of connection.

21. In combination, an internal combustion engine, a fly wheel, a reducing gear set, permanently in mesh, an electric motor, connected thereto, a source of electric current, and means of applying same to said motor, means controlled by said motor for connecting said gear set to said engine when the motor reaches approximately its maximum speed, and an inertia device carried on the shaft of said motor, serving to keep the current through the motor at a minimum during the period of its connection to said engine, substantially as described.

22. In combination, an internal combustion engine, a fly wheel therefor, a reducing gear set adjacent thereto and being permanently in mesh but disconnected from the fly wheel, an electric motor, and a source of electric current therefor, and means of applying same to the motor, electromagnetic means controlled by said motor for engaging the gear set and motor with the engine at a predetermined speed, and means carried by said motor shaft for holding the current through the motor at a minimum, while the electromagnetic engaging means is energized, substantially as and for the purpose described.

23. In combination, an internal combustion engine, a reducing gear set permanently in mesh, a motor connected to said gear set, a source of power for said motor and means of applying same to the motor, and electromagnetic means automatically operated by said motor for engaging said gear set with said engine only after a predetermined interval, substantially as described.

24. In combination, an internal combustion engine, a reducing gear set permanently in mesh, a motor connected to said gear set, a source of power for the motor and means of applying same to the motor, and automatic means carried by an element of the gear set for connecting itself to said engine.

25. In combination, an internal combustion engine, a reducing gear set permanently in mesh, one element being adapted to slide on its bearing, a motor, a source of current for the motor and means of applying current to the motor, electromagnetic means associated with the slidable element and under the control of said motor to cause the same to slide and engage with a secured member on the rotatable shaft of the engine only after a predetermined speed of the motor has been reached, substantially as described.

26. In combination, an internal combustion engine, a reducing gear set permanently in mesh, a motor connected to said gear set, a source of power for the motor and means of applying same to the motor, and electromagnetic means carried by an element of the gear set and controlled by said motor for connecting itself to said engine.

27. The combination of a non-self-starting engine, a self-starting motor and a magnetically controlled clutch acting independent of the current through the starting motor, connecting the engine and the motor after a predetermined speed of the motor has been reached.

28. The combination of a non-self-starting engine, a self-starting motor and a magnetically controlled clutch acting independent of the current through the starting mo-

tor connecting the engine and the motor after a predetermined speed of the motor has been reached, and automatic means for disabling the magnetically controlled clutch at a second predetermined speed.

29. The combination of a non-self-starting engine, a self-starting motor and a magnetically controlled clutch acting independent of the current through the starting motor, connecting the engine and the motor after a predetermined speed of the motor has been reached, and a governing device operating to disable said magnetically controlled clutch after said engine is started.

30. The combination of a non-self-starting engine, a self-starting motor and a magnetically controlled clutch connecting the engine and motor, said magnetic clutch consisting of a solenoid and brake-band, and means operated by said engine when it starts under its own power for disabling said magnetically controlled clutch.

31. The combination of a non-self-starting engine, a self-starting motor and a magnetic device operating to connect said motor to said engine, said magnetic device being brought into operation at a predetermined speed of the motor, and means operated by said engine when it starts under its own power to disable said magnetic device whereby said motor will be released from said engine.

32. The combination of a non-self-starting engine, a self-starting motor and a magnetic device operating at a predetermined speed to connect said motor to said engine, means operated by said engine when it starts under its own power to disable said magnetic device and means manually operable to disable said magnetic device should said engine fail to start under its own power, whereby said motor will be released from said engine.

33. The combination of a non-self-starting engine, a self-starting motor and a magnetically controlled clutch consisting of a solenoid and brake-band operating to connect said motor to said engine, means operated by said engine when it starts under its own power for disabling said magnetically controlled clutch and means manually operable to disable said magnetic clutch should said engine fail to start under its own power.

34. The combination of a non-self-starting engine, a self-starting motor and a magnetically controlled clutch acting independent of the current through the starting motor connecting the engine and motor after a predetermined speed of the motor has been reached, automatic means for disabling the magnetically controlled clutch at a second predetermined speed and manually operable means for disabling said clutch should said second speed be unattained.

35. In combination, an internal combustion engine, a reducing gear set permanently in mesh, a motor connected to said gear set, a source of power for said motor and means of applying same to the motor, electromagnetic means locked in a working position at a predetermined speed of said motor whereby said gear set is engaged with said engine and manually operable means for breaking the lock through said electromagnetic means to disconnect the gear set from said engine.

In testimony whereof I affix my signature in the presence of two witnesses.

ALBION D. T. LIBBY.

Witnesses:

FRANK H. MAHER,

JAMES M. WILSON.