Nov. 27, 1923. **1,475,485**

H. H. GORDON

STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES

Filed Aug. 11, 1919 4 Sheets-Sheet 1

Fig. 4.

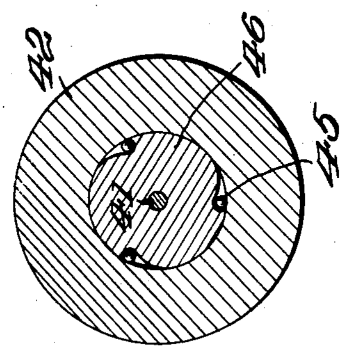
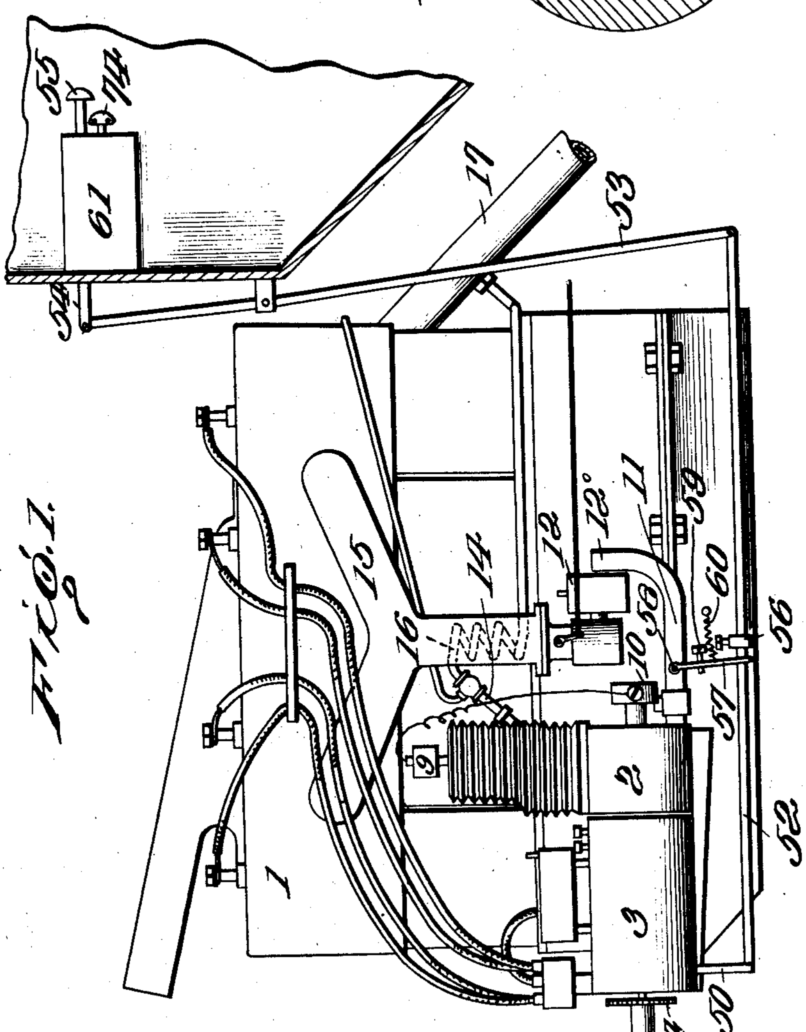


Fig. 1.



Inventor

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STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES

Filed Aug. 11, 1919 4 Sheets-Sheet 2

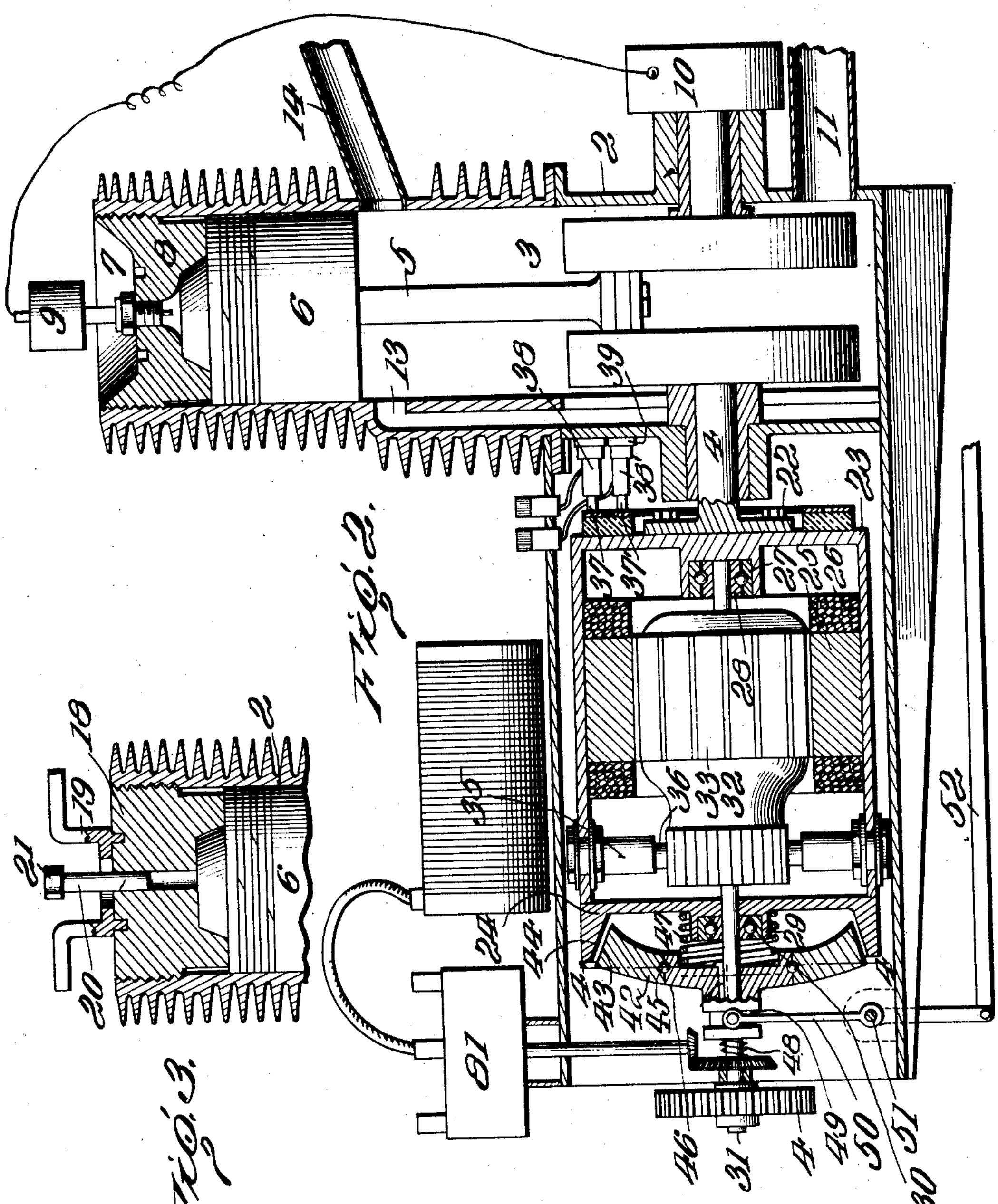

Fig. 2.

Fig. 3.

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STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES

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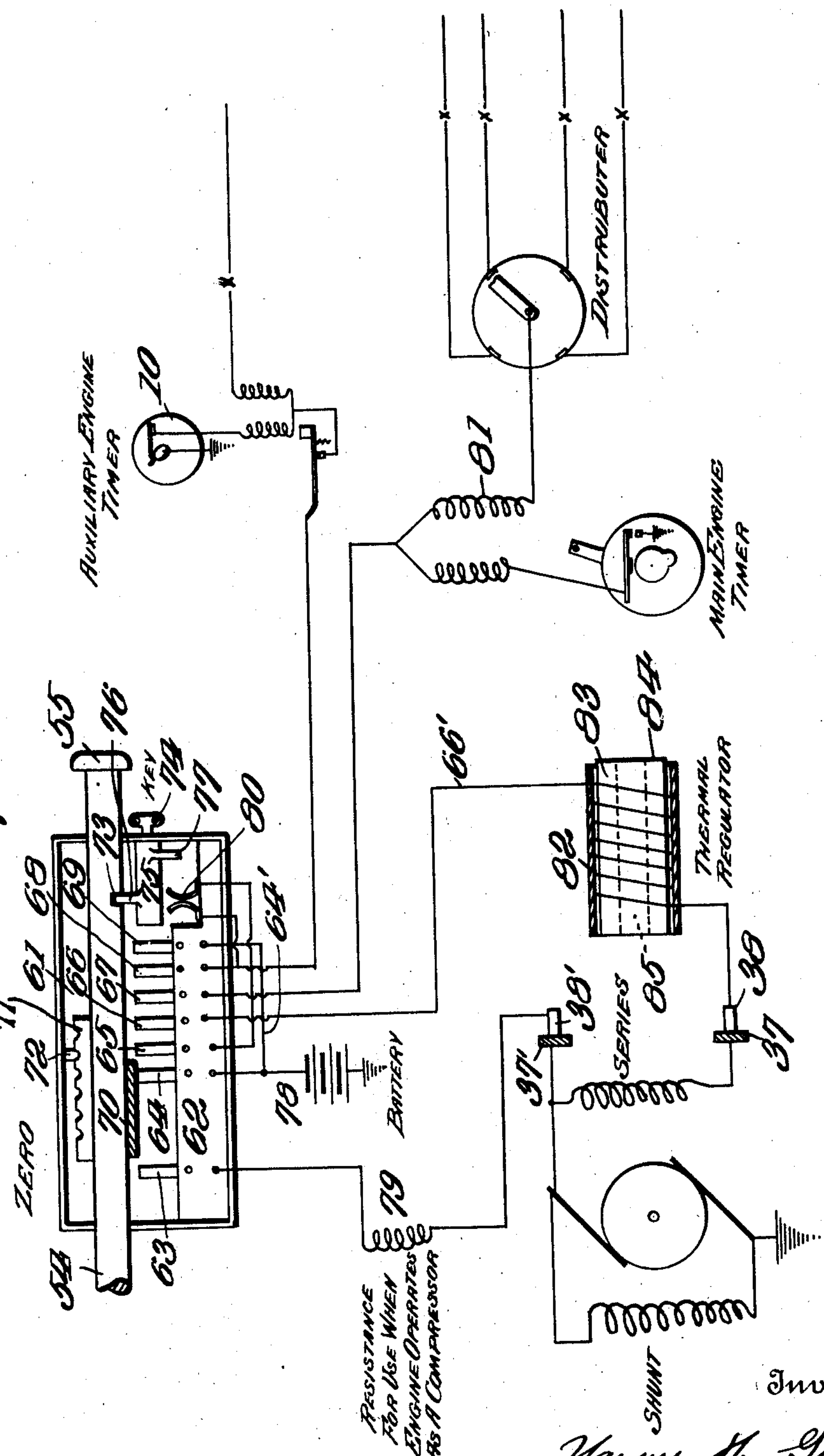
4 Sheets-Sheet 3



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STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES

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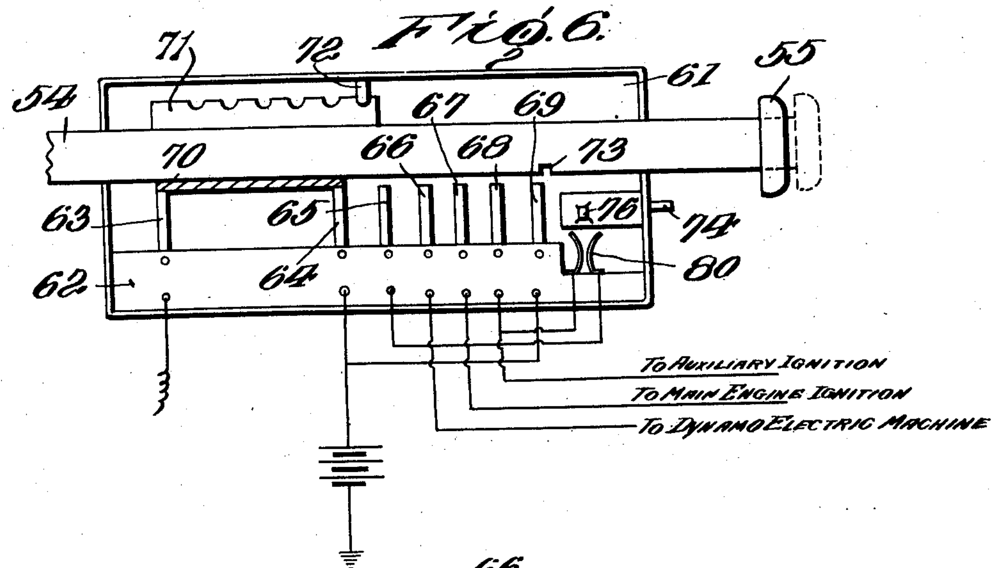
Fig. 6.



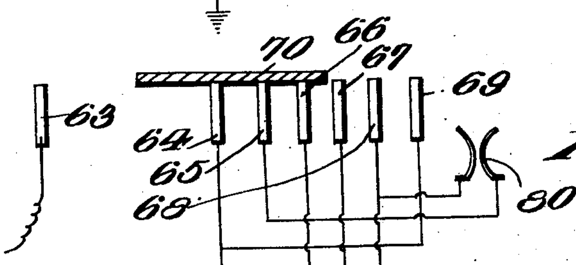


Fig. 7.

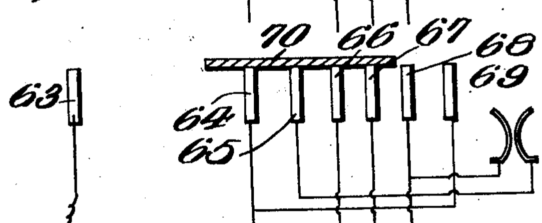


Fig. 8.

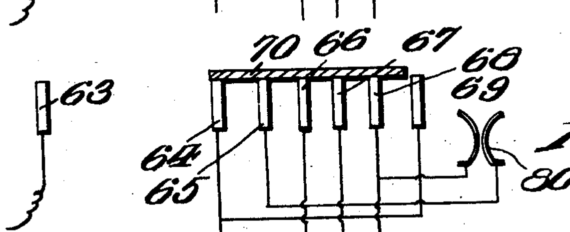


Fig. 9.

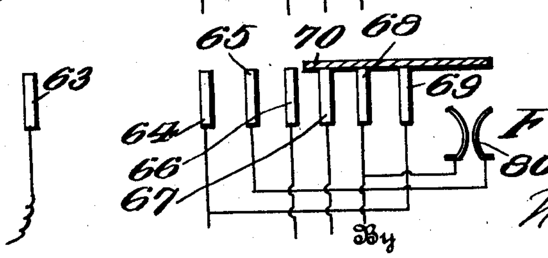


Fig. 10.

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By

Attorney

Patented Nov. 27, 1923. **1,475,485**

UNITED STATES PATENT OFFICE.

HAYNER H. GORDON, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO INDUSTRIAL RESEARCH CORPORATION, OF TOLEDO, OHIO, A CORPORATION OF DELAWARE.

STARTING MECHANISM FOR INTERNAL-COMBUSTION ENGINES.

Application filed August 11, 1919. Serial No. 316,862.

To all whom it may concern:

Be it known that I, HAYNER H. GORDON, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Starting Mechanism for Internal-Combustion Engines, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention provides means for the ready setting in motion of an internal combustion engine and effecting its normal operation. The internal combustion engines which are customarily used on vehicles and in stationary power plants must be set in motion prior to their normal operation, and this invention includes means and methods to accomplish this result.

As ordinarily set in motion from independent motive plants, it has been necessary to utilize a starting unit which is capable of overcoming the inertia of the internal combustion engine and its associated parts, and this necessitates the use of a starting unit of considerably larger size than is ordinarily required for the generation of electric current for lighting and ignition. This invention makes possible the use of a unit of moderate size and one which, while large enough to generate current for ignition and lighting, need not be large enough to deliver motive power capable of overcoming the inertia of the internal combustion engine itself. I have disclosed in this invention means interposed between the electrical starting unit and the internal combustion engine adapted, when put in motion by the electrical starting unit, to overcome the inertia of the internal combustion engine and set it in normal operation. This means has been provided in the form of an auxiliary internal combustion engine of sufficient size to set the main internal combustion engine in operation. In this way the electrical starting unit need be only large enough to set in motion the auxiliary internal combustion engine which, in turn, will start the main internal combustion engine.

One of the advantages of using my starting system will be a reduction in the load imposed upon the storage battery in the starting operation. Since it will be evident that the small electrical starting unit has to put in motion only the auxiliary internal combustion engine, a distinct advantage results over such systems of electrical starting in which the load on the system and the storage battery is the full inertia of the internal combustion engine.

Another advantage to be obtained by this method of starting is an insurance against the battery discharging continuously at a high rate during the starting operation.

It will further be evident from the description of the mechanisms involved that I have provided means for restoring the electrical circuits to the normal running condition as soon as starting impulse has been given.

My invention further provides for recharging an exhausted storage battery without the necessity of utilizing the main engine. A consequent saving of energy and fuel is therefore evident.

The power plant of an automobile is frequently relied upon to furnish compressed air for inflating tires and the like. My invention includes means to accomplish this end by the use of the auxiliary engine rather than by the larger power plant.

Where it is desirable to make use of one form of fuel for starting the engines and a second form of fuel of heavier nature for maintaining them in operation, this is accomplished by providing two sources of fuel supply and means to connect either source with the carbureter.

Other advantages will be apparent and evident from the structure disclosed in the following description by way of example.

Referring to the drawings:

Figure 1 is a side view of an internal combustion engine adapted for use in a motor vehicle and including one form of the starting mechanism hereinafter claimed;

Figure 2 is a vertical longitudinal section through the starting mechanism shown in Figure 1;

Figure 3 is an alternative form of the cylinder head in the auxiliary engine:

Figure 4 shows a vertical cross section along the line 4—4 of Figure 2;

Figure 5 is a diagrammatic showing of the electrical circuits and the control switch and key;

Figure 6 illustrates a switch plunger in position for use when the auxiliary engine operates as an air compresser;

Figure 7 illustrates the switch contacts when the auxiliary engine is used to recharge the storage battery. The circuits are closed only when the key member 76 connects the switch points 80;

Figure 8 shows the normal position of the switch contacts during the normal operation of the main engine;

Figure 9 shows the switch contacts in the transition point, having closed the circuit to the auxiliary ignition previous to starting the auxiliary engine;

Figure 10 shows the position of the switch contacts during the initial starting operation. Provision is here made for the auxiliary engine and the main engine ignition circuits to be closed. In this position of the plunger the clutch 42 is in engagement with the clutch member 43.

By way of example the drawings show a four stroke cycle four cylinder engine indicated generally by the numeral 1. Associated with this engine in convenient arrangement thereto is the starting unit consisting of the auxiliary internal combustion engine 2 and the electric dynamo-motor 3. Gearing 4 connects the moving parts of the dynamo and auxiliary engine with the crank shaft of the main internal combustion engine.

The auxiliary engine 2 is of the two stroke cycle type, has a crank case 3 containing the crank shaft 4′, the crank 5 to which is connected the piston 6. The upper end of the cylinder is closed by the screw-threaded top 7 cooperating with interior screw threads, this being of breech block construction if desired. Centrally disposed in the upper member 7 is found a jump spark plug 9 which, as shown, has a self contained inductive coil integral therewith. This sparking device is electrically connected to the timer 10 which is mounted directly on one end of the crank shaft 4 and operates to produce a spark at the proper interval in the stroke of the piston 6. The intake port for the gaseous fuel is shown at 11, this port drawing the gaseous fuel from the carbureter 12. The port 13 permits the gas to be pumped into the explosion chamber in the usual manner in which two-stroke cycle engines operate, the exhaust being provided for through the pipe 14. Pipe 14 passes through the intake manifold 15 of the internal combustion engine and includes within said manifold a main heating coil 16. The exhaust gases having passed through the coil 16 are delivered into the exhaust manifold 17 of the main engine.

As disclosed, the fuel supply for the auxiliary engine is obtained from an auxiliary nozzle and associated air inlet 12°, constructed as part of the main carbureter. It may be advisable, however, to supply the fuel to the auxiliary engine by means of a separate auxiliary carbureter entirely separate and distinct from the main carbureter. By this construction it is possible to run the auxiliary starting engine on a "high test" fuel, and operate the main engine on "low grade" fuel.

Since the two grades of fuel require elevated temperatures for their effective vaporization, this is accomplished by the main heating coil 16.

In the event that it is desired to use a heavier grade of fuel during operation and after the initial starting with a lighter fuel, provision may be made for continuously heating the inlet of heavy fuel after the flow of hot exhaust gases from the auxiliary engine has stopped, by reason of the stoppage of the latter. An example of such provision is shown in Figure 1 where a two-way valve is placed upon pipe 14 between the auxiliary engine and the heating coil. A tube leads from the main exhaust manifold to the two-way valve. During the starting operation the coil is heated from the auxiliary engine, but as soon as the main engine functions, the coil is heated from the exhaust of the latter. The operation of the valve may be either manual or mechanical, or, in certain circumstances, it may be omitted.

In Figure 3 is shown an alternative structure to be used in place of the cylinder head of the engine shown in Figure 2. This head 18 screws into the cylinder 2 and is used, as will be hereinafter described, when the smaller engine is operated as an air compresser. This head 18 is applied by means of the handle 19. Centrally disposed in the member 18 is the pipe 20 and fastening 21, to which a conventional air line may be applied for pumping tires or other analogous uses.

The forward end of the crank shaft 4 is given a flange form 22. Mounted upon the flange 22 is a field frame 23 at the opposite end of which there is carried the circular casting 24. Carried on the cylindrical inner surfaces of the frame 23 are the field poles 25 and field windings 26 of a dynamo electric machine. Centrally disposed in the end of the frame 23 is the boss 27 containing antifriction means 28. Similarly carried in the boss 29 of disk casting 24 is the antifriction member 30. A shaft 31 is journaled in the antifriction members 28 and 30 and this shaft carries in juxtaposition with the field poles 25, the armature 32 and its winding 33. The commutator 34 is mounted upon the armature and in contact with the brushes 36. These brushes 36 are held in mountings 35 oppositely disposed upon the frame 23.

Mounted on the end of frame 23 will be found two concentric ring commutators 37 and 37′ in contact with brushes 38 and 38′, respectively, the brushes being held in mountings 39. Where not desired to use the auxiliary engine as a pump, only one ring commutator 37 and its coacting brush are necessary. The mountings 39 are mounted upon the outer wall of the auxiliary engine crank case. The brushes 38 are connected by wires to the outlets 40.

Keyed upon the shaft 31 by means of the key 41 is the over-running clutch combination consisting of the outer member 42 having conical bearing surface 43 held opposite a conical bearing surface 34 of the casting 24. On the inner periphery of the member 42 rides a plurality of clutch rollers 45 recessed in the outer periphery of the disk 46. This disk 46 is keyed to the shaft in the manner above mentioned and by reason of the recesses in its outer periphery serves as an overrunning clutch. The member 46 is slidable longitudinally of the shaft 31 and is held in position by the spring 47 and the opposing spring 48. The inner member 46 of the clutch carries a grooved collar 49. A yoked lever 50 operates in the groove of the collar 49, has its fulcrum frame structure at 51 and its opposite end is connected to the lever 53 with which cooperates the controlling plunger 54. The outer end of the plunger 54 extends through the switch box on the dashboard, or other convenient part of the vehicle, and is equipped with a handle 55 for its manipulation. The link 52 carries adjustably a collar 56 against which rides a lever 57 pivoted at 58 upon the intake manifold of the auxiliary engine or upon some convenient part of the frame. The movement of the lever 57 is limited by the stop 58 riding against the lug 59 on the frame. The lever 57 is held in its rearward position by means of the spring 60.

A switch box 61, through which the plunger 54 operates, carries a plate 62 from which extend the insulated contacts 63, 64, 65, 66, 67, 68 and 69. The plunger 54 is of non-conducting material and carries on its lower surface the conducting plate 70. Opposite to this plate is carried the recess member 71. Upon the adjacent wall of the switch box 61 is found the spring pressed member 72 which cooperates with the recesses in the plate 71 to retain the plunger in adjusted position. On the same side of the plunger with the plate 70 is placed the recess 73. A key 74, insertable through the wall of the box 61, serves to rotate a locking device 75, one projection of which, 76, cooperates with the recess 73 of the plunger, while an opposite projection 77 may be made to hold the plunger in retracted position by engagement with the recess 73.

The systems of electrical connections are illustrated in Figures 5 to 10 inclusive and include a battery 78 connected to the contact 64. The contact 63 is connected through the resistance 79 and brush and ring 37′, 38′ to the electrical unit in the manner illustrated in the diagram. This connection is established when the plunger is at its innermost position and provides for the slow rotation of the field magnets around the stationary armature, thus operating the auxiliary engine as an air compressor. Contact 64 is connected directly to one terminal of a storage battery 78, the other terminal of the same being grounded. This contact is therefore the main battery contact but connected thereto by a lead 64′ is a supplemental contact 69. Contact 66 is connected by a lead 66′ to a thermal regulator 82 which is in turn connected through brush 38 and copper split ring 37 to the series field of the dynamo electric machine, the armature thereof and thence to ground.

The thermal regulator 82 consists of a coil 83 of resistance wire, such as iron, having a high temperature coefficient, wound upon a metallic core 84. The resistance winding is preferably in the form of strip and is insulated from a metallic core by a very thin heat conducting insulation such as mica. The core 84 is composed of material having a high specific heat, the core therefore acting as a heat reservoir. The weight of the core is so selected with reference to the specific heat, the size of wire, average amount of energy passing therethrough, etc., that at ordinary rates of current flow through the resistance winding, the heat radiation from the core will be greater or equal to the heat received from the wire and no perceptible rise in temperature and, therefore, resistance of the wire will take place. In order to provide this radiation, an opening 85 may be provided centrally of the core. While the metallic core is illustrated as a heat reservoir, a fluid medium, such as mercury, or even water, with its high specific heat may be employed. At ordinary running speeds the current flow is insufficient to cause a rise in temperature and therefore a resistance in the coil.

When the generator operates to charge the battery, the core radiates in proportion as it receives heat and there is no rise in temperature. During the starting operation a heavy flow of current passes through the regulator. This lasts for a short duration. The core forms a reservoir to hold the heat and its capacity must be satisfied before the resistance wire rises in temperature. The rise in resistance is therefore delayed until after the starting operation has been accomplished.

At slow speeds and where the generator motorizes for any period of time, the flow of current in the regulator will be such as to increase the resistance and therefore automatically prevent the motorizing.

By the use of this regulator in the above operations, there is accomplished the avoidance of other forms of regulators necessitating expensive contacts and arcing circuit breakers.

Contact 67 is connected directly to the main engine ignition coil 81, while contact 68 is connected to the auxiliary engine ignition system. Contact 65 is adapted to be placed in connection with contact 68 by means of a pair of contact springs 80 which, when desired, may be connected by means of the locking lug 73 carried by the barrel 75 and operated by the key 74.

When in its normal position, plate 70 contacts with the element 64 only.

The following movements of the plunger take place during the operation of starting the main internal combustion engine. The switch 75 is released by a quarter turn of key 64 and the plunger 54 slowly withdrawn. When the plunger reaches the position as shown in Figure 7, contact 66 is connected to battery contact 64 and the dynamo electric machine is thereby energized, functioning as a motor.

Passing through positions shown, respectively, in Figures 8 and 9, the main engine ignition is first connected to the battery by means of contact 67 and the auxiliary engine ignition subsequently connected with the battery by contact 68. At this point the auxiliary engine takes up its function, being rotated by the field which revolved about the armature, the latter held stationary by the torque of the main engine with which it is in engagement by gear 4.

After passing the position shown in Figure 8, further outward movement of the plunger 54 is obtained against tension of the spring 60, collar 55 having been up against arm 57. This movement opens the throttle of the auxiliary engine and, at the same time, causes the clutch member 43 to engage member 44. At this time the plate 70 is in the position indicated in Figure 10, the dynamo electric machine being disconnected from the battery and the ignition systems of both the main and auxiliary engines receiving their current from the supplemental battery contact 69. When the clutch members engage, as just stated, the field and armature structure of the dynamo electric machine is locked together as a solid unit, and the auxiliary engine functions through the gearing 4 to crank the main engine. As soon as the main engine takes up its cycle, part 42 of the clutch over-runs the hub member 46, these elements functioning as an over-running clutch, thereby automatically permitting the main engine to over-run the auxiliary engine.

As soon as the main engine starts, the plunger is released and is automatically returned to position shown in Figure 8 by means of spring 60, whereby the ignition of the auxiliary engine is interrupted by the plate 70 ceasing to make contact with member 68.

During normal running the compression in the auxiliary engine prevents the field member of the dynamo electric machine from rotating, and the armature is rotated by the main engine. The dynamo now functioning as a differentially wound generator, furnishes current of approximately constant potential to the battery.

If the battery, by virtue of disuse or other causes, has become too weak to carry out its ordinary function, it may be charged directly by the operation of the auxiliary engine. For this purpose the plunger is pulled out to the position indicated in Figure 7 and the key 74 is given a half turn. The dynamo electric machine is thereby connected to the battery and the auxiliary engine ignition system is energized through contacts 65, plates 80 and projection 73. The auxiliary engine is thereby started and operates the dynamo electric machine as a generator with stationary armature and rotating field to recharge the battery, the stop 58 being adjusted against the lug 59, gives suitable throttle opening for this purpose, while the release clutch members leave the main engine idle. In this position the auxiliary engine supplies current to the battery and for its own ignition purposes. Measuring devices may, of course, be placed in the battery circuit to determine the length of time during which this operation should be carried out.

The structure of the auxiliary engine is well adapted for use as an air compresser, and means are provided for its operation to compress air for inflating tires, and other obvious uses. To accomplish this result it is only necessary to push the plunger 54 to its innermost position in the switch box. The conducting plate 70 will then close the circuit from the battery through the member 64 to the member 63, thence through resistance 79 and to the electrical unit. By the interposition of the added resistance 79, it is possible to so adjust the sped of the electrical unit, that is, the rotation of the field around the stationary armature, that the auxiliary engine can properly be used as an air compresser. The cylinder head shown in Figure 3 will be used on the auxiliary engine and will serve to provide an outlet for the compressed air. Suitable inlet ports for the intake of the air will be used in place of the gas inlet.

It will be obvious that the main engine ignition circuit will be opened and the engine brought to a stop by restoring the plunger to its normal position.

Throughout the specification and claims

the term "motor-generator" has been employed. In the employment of this term it is intended that it should receive a broad interpretation equivalent to the term dynamo electric machine, as descriptive of an electrical apparatus capable of use either as a motor or as a generator and having a single or double set of either armatures or field windings or actually separated units.

It will be clear to one skilled in this art that the above assemblage of devices comprises a system for starting an internal combustion engine with the minimum expenditure of energy and with a most convenient engagement of parts. There is also provided a means for recharging the storage battery and for producing useful work, such as compressing air, incidental to the main starting function and without the necessity of setting in operation the main internal combustion engine.

What I claim as my invention is:

1. In a device for starting an internal combustion engine, the combination of an auxiliary engine, a source of electric current, an electric motor-generator in circuit therewith having two relatively rotatable members, driving connection between one of said members and the auxiliary engine, driving connection between the other of said members and the internal combustion engine, and means to cause the motor members to rotate in unison.

2. In a device for starting an internal combustion engine, the combination of an auxiliary engine, a source of electric current, an electric motor-generator in circuit therewith having two relatively rotatable members, one of said members adapted for rotation with a shaft of said auxiliary engine, the other of said members having a driving connection with the internal combustion engine, and means to cause the motor members to rotate in unison.

3. In a device for starting an internal combustion engine, the combination of an auxiliary engine, a source of electric current, an electric motor-generator in circuit therewith having two relatively rotatable members, one of said members adapted for rotation with the shaft of said auxiliary engine, the other of said members having a driving connection with the internal combustion engine, and means to cause the second said member to rotate with a speed equal to the first said member.

4. In a device for starting an internal combustion engine, the combination of an auxiliary engine, a source of electric current, an electric motor-generator in circuit therewith having two relatively rotatable members, one of said members adapted for rotation with the shaft of said auxiliary engine, the other of said members having a driving connection with the internal combustion engine, and means permitting the latter member to overrun the former member.

5. In a device for starting an internal combustion engine, the combination of an auxiliary engine, a source of electric current, an electric motor-generator in circuit therewith having two relatively rotatable members, one of said members adapted for rotation with the shaft of said auxiliary engine, the other of said members having a driving connection with the internal combustion engine, friction means to cause the motor members to rotate in unison and an overrunning clutch between said friction means and the internal combustion engine.

6. In a device for starting an internal combustion engine, the combination of an auxiliary engine, a source of electric current, an electric motor-generator in circuit therewith having two relatively rotatable members, one of said members adapted for rotation with the shaft of said auxiliary engine, the other of said members having a driving connection with the internal combustion engine, an overrunning clutch in keyed engagement with one of the members and a friction device connected with the clutch and in engagement with the other member.

7. In an electrical system for a power unit, a main internal combustion engine, an auxiliary internal combustion engine, a motor-generator operably connected therebetween, ignition circuits for said engines, regulating means in circuit with said motor-generator, a parallel resistance circuit in circuit with said motor-generator and a common source of current selectably connected with said circuits.

In testimony whereof I affix my signature.

HAYNER H. GORDON.