A. SUNDH.

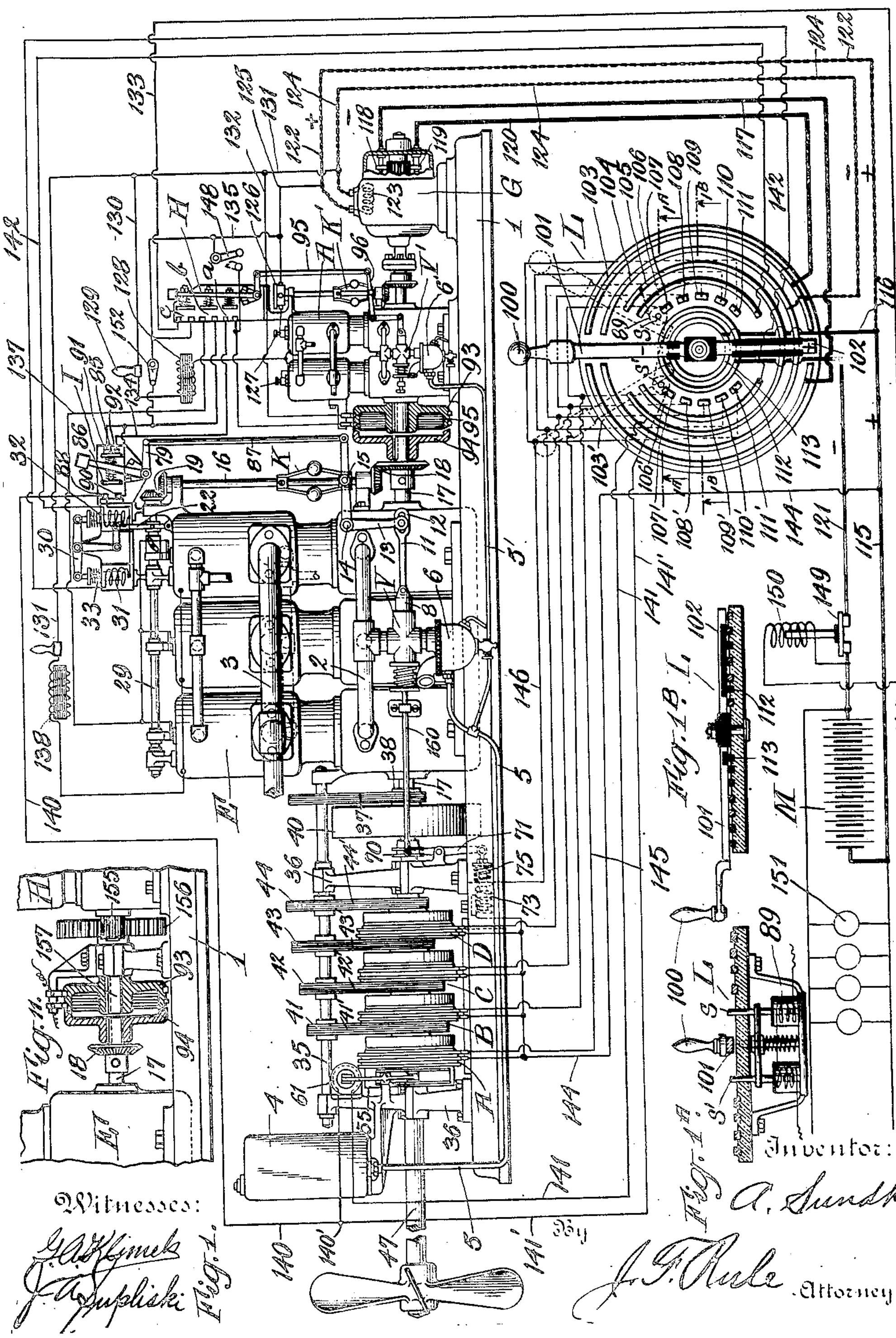
STARTING AND CONTROLLING EXPLOSIVE ENGINES.

APPLICATION FILED AUG. 2, 1909.

1,102,455.

Patented July 7, 1914.

3 SHEETS—SHEET 1.



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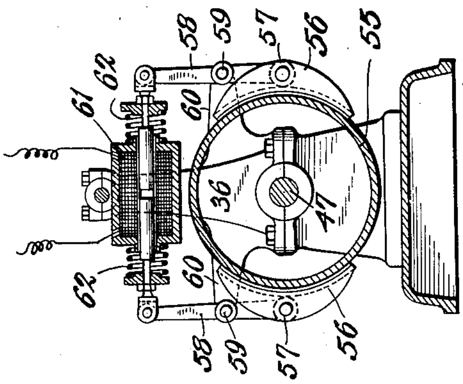

Fig. 3.

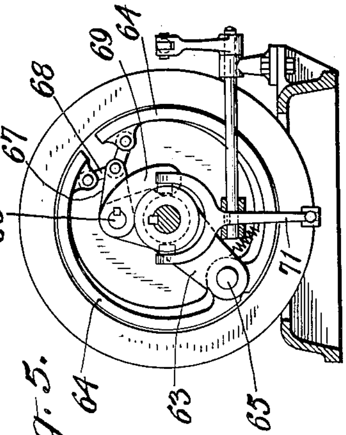

Fig. 5.

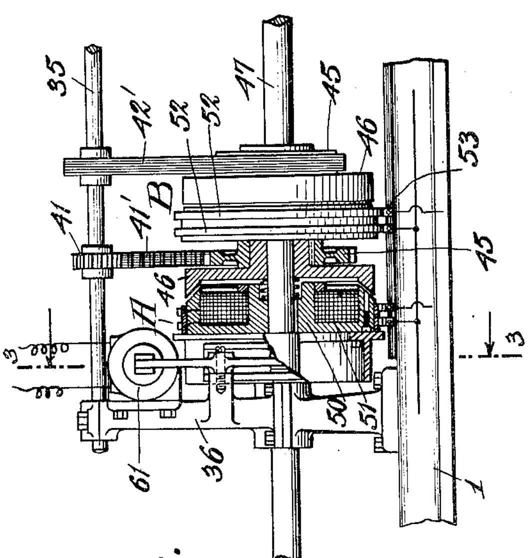

Fig. 2.

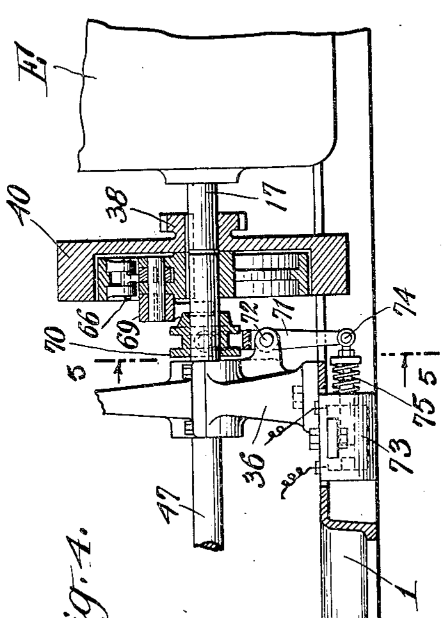

Fig. 4.

Witnesses:

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J. A. Supliski

Inventor:

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By J. F. Rule. Attorney

A. SUNDH.

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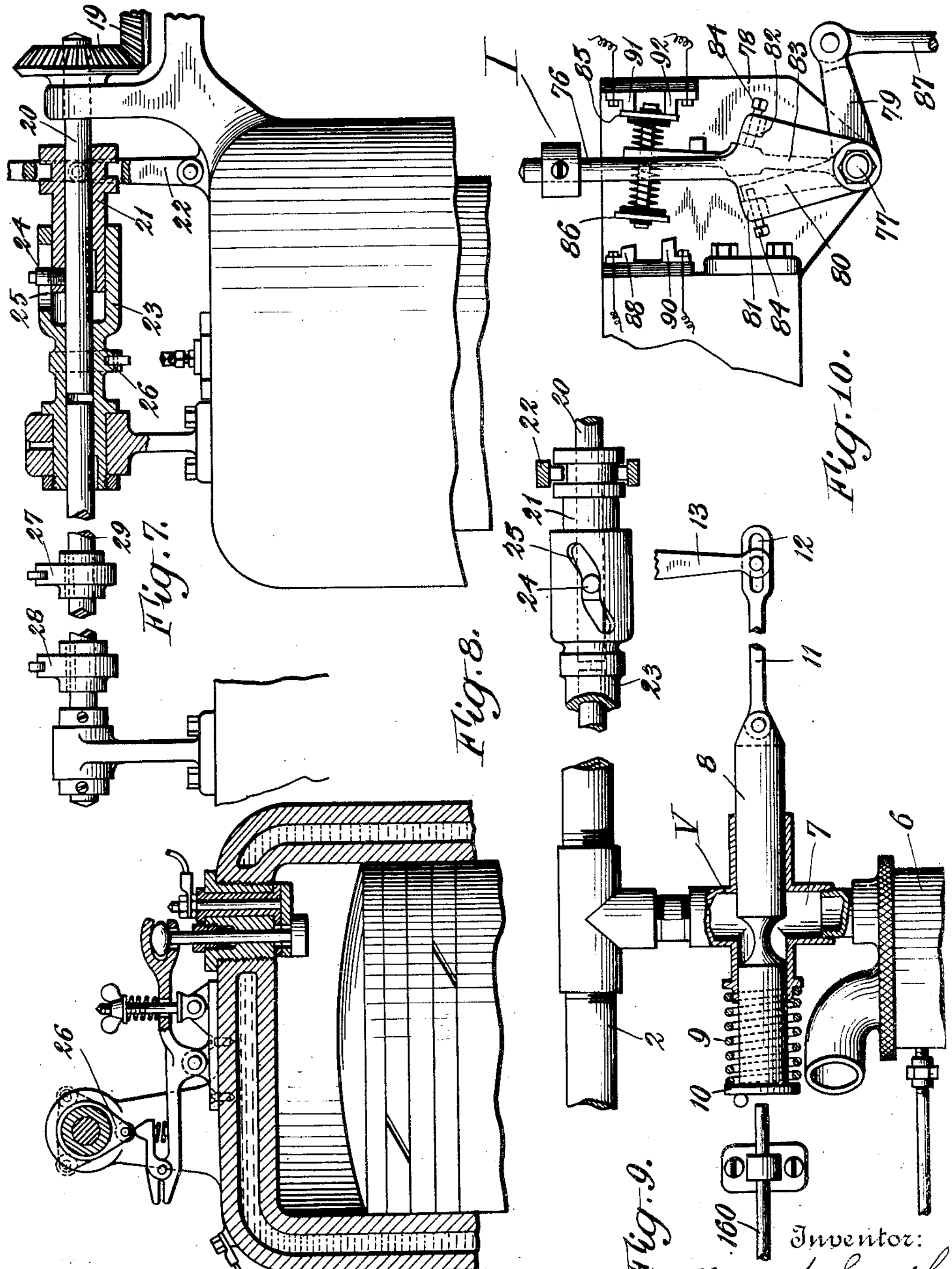

Fig. 6.

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UNITED STATES PATENT OFFICE.

AUGUST SUNDH, OF YONKERS, NEW YORK, ASSIGNOR TO OTIS ELEVATOR COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

STARTING AND CONTROLLING EXPLOSIVE-ENGINES.

1,102,455. Specification of Letters Patent. Patented July 7, 1914.

Application filed August 2, 1909. Serial No. 510,742.

To all whom it may concern:

Be it known that I, AUGUST SUNDH, a citizen of the United States, residing at Yonkers, in the county of Westchester and State of New York, have invented a new and useful Improvement in the Starting and Controlling of Explosive-Engines, of which the following is a specification.

My invention relates to means for starting and controlling the operation of an explosive engine and power transmission mechanism associated with the engine.

The invention broadly comprises a main explosive engine, an auxiliary explosive engine for starting the main engine, a motor for operating the auxiliary engine, a storage battery for supplying power to the motor, variable speed power transmitting mechanism, and a system of electrical control associated with said parts.

An object of the invention is to provide a reliable and effective device for starting and controlling an explosive engine and associated power transmitting mechanism, and which device may be controlled with a minimum of manual labor.

Other objects of the invention, and the exact nature of the same will fully appear hereinafter; the scope of the invention and the novel combinations of elements being set forth in the appended claims.

In the accompanying drawings which illustrate an embodiment of the invention, Figure 1 is a side elevation of an internal combustion engine and associated mechanism as used in carrying out my invention, and showing diagrammatically, the system of electrical circuits and various electrical devices employed; Figs. 1^A and 1^B are sectional views of the controller taken substantially as indicated by the lines 1^A—1^A and 1^B—1^B, respectively of Fig. 1, Fig. 1^A also showing a stop device for the controller lever; Fig. 2 is a side elevation partly in section, showing some of the magnetic clutch devices and brake mechanism associated therewith; Fig. 3 is a sectional elevation view of the brake mechanism, the section being taken substantially on the line 3—3 of Fig. 2; Fig. 4 is a sectional side elevation view of one of the clutches and its connected parts; Fig. 5 is an end view of a clutch shown in Fig. 4; Fig. 6 is a sectional elevation on a larger scale, of the top of one of the engine cylinders, and showing in detail, the sparking mechanism; Fig. 7 is a fragmentary side elevation partly in section of the sparking mechanism; Fig. 8 is a plan view of one of the details of the sparking mechanism; Fig. 9 is a side elevation partly in section of a throttle or regulating valve together with some of its connected parts; Fig. 10 is an elevation view of one of the switch mechanisms; Fig. 11 is a modification showing speed reducing gearing between the two engines.

The main engine E, the auxiliary engine A, the generator G, and the power transmitting mechanism are all preferably mounted upon the same base or bed plate 1. The engine E may be of any preferred type or form, and in the present case is shown as a three-cylinder two-cycle gasolene engine having an intake or supply pipe 2, and an outlet or exhaust pipe 3. A gasolene supply tank 4 is connected by a pipe 5 with a carbureter 6, and the latter is connected with the intake pipe 2 through a regulating or throttle valve V. The throttle valve V, as shown in detail in Fig. 9, controls a passage 7 leading from the carbureter 6 to the intake pipe 2. The piston valve 8 is held in its left-hand position, as shown, by a compression spring 9 bearing at one end against the valve casing, and at its opposite end against the flange 10 on the valve. With the valve in this position, the passage 7 is partially closed. A rod 11 is pivoted at one end to the valve member 8, and at its opposite end is formed with a slot 12 forming a lost motion connection with the vertical arm of a bell-crank lever 13. The latter is pivoted at 14 to the engine frame, and has a horizontal arm connected at 15 to a centrifugal speed governor K. The latter is mounted on a vertical shaft 16 which is driven by the engine shaft 17 through bevel gears 18. The upper end of the rod 16 is connected through gears 19 with a horizontal shaft 20 for actuating the sparking mechanism.

As shown in Fig. 7, a sleeve 21 is splined on the shaft 20 so as to rotate therewith, but may be moved longitudinally on the shaft by means of a lever 22. A sleeve 23 is loosely mounted on the outer end of the shaft 20 and extends over the end of the sleeve 21. A pin 24 carried by the sleeve 21 extends through a cam slot 25 in the sleeve 23. The sleeve 23 carries a cam 26 which is arranged to actuate a sparking device such as shown in Fig. 6, for one of the engine cylinders. Similar cams 27 and 28 are mechanically connected to the sleeve 23 through a shaft 29 for operating the sparking mechanisms on the other engine cylinders. As this sparking mechanism is well known in the art, a further description thereof in this place is unnecessary.

The lever 22 is operated by a T-lever 30. Electromagnets 31 and 32 are connected to operate the T-lever in opposite directions, and springs 33 return said lever to central position when the magnets are deënergized. If the magnet 31, for example, is excited, it will operate through the T-lever 30 to swing the lever 22 to the right, carrying with it the sleeve 21 and pin 24; the latter, by rotating the sleeve 23 on the shaft 20, effects an advance in the sparking in a well understood manner. The magnet 32 serves to advance the spark when the engine is run in a reverse direction.

A counter-shaft 35 is supported by standards 36 mounted on their base 1. This shaft is positively driven from the engine shaft 17 by means of a sprocket chain 37 running over the sprocket wheel 38 keyed to the engine shaft, and over a similar sprocket wheel on the counter-shaft. The sprocket wheel 38 may be a part of a member 40 which forms a fly wheel for the engine, and also a part of a clutch, as hereinafter explained. Sprocket wheels 41, 42, 43 and 44 of different sizes are rigidly mounted on the counter-shaft 35 and connected by sprocket chains 41′, 42′, 43′ and 44′ to sprocket wheels 45 keyed to magnetic clutch members 46 loosely mounted on the shaft 47, as shown in Fig. 2. The clutches on the shaft 47 are designated respectively, A, B, C and D. As shown in Fig. 2, each of these clutches comprises a member 50 keyed to the shaft and carrying a magnet coil 51. When the latter is excited, the clutch member 46 is drawn into frictional engagement with the member 50, so that motion is transmitted to the shaft 47 from the counter-shaft 35. The terminals of magnet coils 51 are connected to collector rings 52 against which bear the contact brushes 53. The clutches A, B, C and D are adapted to be operated successively, as will appear later, and owing to the difference in diameters of the sprocket wheels 41, 42, 43 and 44, the speed of the driven shaft 47 will be gradually accelerated. The shaft 47 may be connected to any mechanism which it is desired to operate by power supplied from the engine. As here shown, this shaft forms a propeller shaft for a boat.

The brake mechanism comprises a brake pulley 55 secured to the shaft 47 so as to rotate therewith. Brake shoes 56 are arranged to bear upon the brake pulley. These brake shoes are pivoted at 57 to brake levers 58; the latter are pivoted at 59 to arms 60 extending from the standard 36. An electro-magnet 61 when energized, lifts the brake shoes, and when the electro-magnet is deënergized, brake springs 62 apply the brake shoes to the pulley 55.

In Figs. 4 and 5 is shown the clutch for connecting the engine shaft 17 directly with the driven shaft 47. This clutch comprises the driving member 40, before referred to, which is keyed to the engine shaft 17 and is made heavy in order to form a fly wheel for the engine. The driven member 63 of the clutch is keyed to the shaft 47, and comprises clutch shoes 64 pivoted at 65 to the body portion of the driven member. A stud shaft 66 is journaled in the clutch member 63 and carries a crank arm 67 connected by links 68 to the clutch shoes 64. An arm 69 also keyed to the shaft 66 extends into position to be engaged by a cam surface formed upon the collar 70. The latter is adapted to be moved longitudinally of the shaft 47 by means of a lever 71 pivoted at 72 to the standard 36. An electro-magnet 73 has its core connected at 74 to the lever 71. When the electro-magnet 73 is energized, it operates to move the collar 70 to the right, thereby rotating the stud shaft 66, and through the arm 67 and links 68 expands the brake shoes to frictionally engage them with the driving member. When the magnet is deënergized, the spring 75 serves to effect a disengagement of the clutch members.

The switch I, shown in Fig. 10, comprises a weighted arm 76 pivoted at 77 to a bracket 78. A bell-crank lever 79 also pivoted at 77 has an arm 80 movable into engagement with lugs 81 and 82 formed on the arm 76. A switch arm 83 also pivoted at 77 is adapted to be engaged by adjustable set screws 84 in the lugs 82. The switch arm 83 carries contact plates 85 and 86 movable into engagement with the stationary contacts carried by the bracket 78. A vertical rod 87 is pivoted at its upper end to the bell-crank lever 79, and at its lower end to the bell-crank lever 13. When the governor K operates to lift the rod 87, the switch arm 83 is carried to the left, and the contact plate 86 is brought into engagement with the stationary contacts 88 and 90. When the speed of the governor K falls below a predetermined value, or when the governor is at rest, the weight of the parts carries the weighted arm 76 to the right, and the contact plate 85 is moved into engagement with the stationary contacts 91 and 92.

The auxiliary engine A is adapted to be connected with the engine E through an electro-magnetic clutch comprising a driving member 93 keyed to the shaft of the engine A, and a driven member 94 splined on the main engine shaft 17. This clutch is excited by means of a magnet coil 95. Fuel is supplied to the engine A from the tank 4, through the pipe 5 and a pipe 5′ leading to the carbureter 6′ of the engine A. A switch lever H is connected through a link 95 and bell-crank lever 96 to the governor K′ of the engine A. The governor K′ also controls a throttle valve V′ for the engine A; this valve being similar to that of the engine E.

An electro-dynamic machine G is connected to the auxiliary engine for starting the same, and is adapted to receive current from a storage battery M. The electro-dynamic machine G may also, at times, be driven by the engine A and act as a generator to supply electrical current for recharging the storage battery M.

The various electrical circuits are controlled by a manual controller L. The latter comprises a switch lever having an upper contact arm 101, a lower contact arm 102, and an operating handle 100. When the handle 100 is moved to the right, the upper contact arm is adapted to engage stationary contact strips 103 to 111 inclusive. This movement of the lever also engages the lower switch arm 102 with the contact strip 103′. The movement of the handle 100 to the left brings the contact arm 101 into engagement with the contact strips 103′, 104, 105, 106′ and 107′ to 111′ inclusive. The lower arm also engages the contact strip 103. The switch arm 101 bears continuously on a contact ring 112, and the arm 102 likewise has permanent connection with the contact ring 113. The arm 101 is insulated from the ring 113, as shown, and the arm 102 is likewise insulated from all the contacts except the ring 113 and the outermost contact strips 103 and 103′.

The operation of the invention will be understood from the following description:—When the controller lever is in central position, as shown, the parts are at rest; the circuit for the battery M being open at the controller L. If the handle 100 is now moved to the right, for example, to bring the switch arm 101 into engagement with the contact strips 103 and 104, the lower arm 102 will also engage contact strip 103′, and circuits will be closed to the motor G. The circuit for the motor armature may be traced from the positive terminal of the storage battery, through conductors 115, 116, contact ring 113, switch arm 102, contact strip 103′, conductor 117, to the brush 118, and from the opposite brush 119 through the conductor 120, contact strip 103, switch arm 101, contact ring 112 and conductor 121 to the negative terminal of the battery. The contact rings 113 and 112 being connected respectively to the positive and negative terminals of the battery may be called positive and negative rings. The switch arms 102 and 101 may likewise be called positive and negative arms. A circuit for the field coil of the motor may be traced through the conductors 115, 122, field coil 123, conductor 124, contact strip 104 to the negative arm 101, and from thence to the negative terminal of the battery. A circuit is also established which may be traced from the positive conductor 122, through a conductor 125, a timer 126, and sparking plugs 127 for the engine A, and from thence through a spark coil 128, pilot 129, conductors 130, and 131 to the negative wire 124. As the motor G now receives current, it will be started and also start the engine A. The latter being started operates in the usual way to draw in fuel which is ignited by the spark plugs, so that the engine A will be run by its own power. As the engine A accelerates, the governor K′ will operate the switch lever H to close switches *a*, *b* and *c*, thereby establishing a circuit for clutch magnet coil 95, a circuit for the sparking mechanism of the main engine E, and a circuit for a potential magnet coil 150. The circuit for the clutch magnet coil may be traced from the positive conductor 122 through conductors 125, 135, switch contacts 91, 85, 92, conductor 134, switch *a*, magnet coil 95, and from the latter through conductors 132 and 131 to the negative conductor 124. A circuit may also be traced from the positive conductor 122, through conductors 125, 135, switch *b*, through conductor 137 to the sparking plugs of the engine E, and from thence through the sparking coil 138 and conductor 131 to the negative conductor 124. The magnet coil 95 being energized, the clutch member 94 will be drawn into frictional contact with the clutch member 93, thereby connecting the two engines. The engine E will therefore be started by the auxiliary engine A, and as the speed increases, it will be driven by its own power generated in the combustion chambers of the engine. As the engine approaches its normal speed, the governor K will operate the switch I, and move the contact plate 86 into engagement with the stationary contacts 88 and 90. The contact plate 85 is at the same time withdrawn from the stationary contacts 91 and 92, thereby opening the circuit for the clutch mechanism, and disconnecting the engines. As the movement of the controller arm 101 to the right is continued, it engages the contact strips 105 and 106. The strip 105 controls the circuit for the brake magnet 61, which circuit may be traced from the positive wire 122, through conductors 125, 135, to the contacts 90, 86, 88 of the switch I, and from thence through conductor 140, to the brake magnet; and from thence through conductor 141 and contact strip 105 to the negative switch arm 101. The brake shoes are therefore lifted to permit the shaft 47 to be driven. The contact strip 106 controls the circuit for the magnet 32, which circuit may be traced from the positive wire 122, through conductors 125, 135 to the contacts 90, 86, 88 of the switch I, and from thence through the magnet coil 32, conductor 142, to the contact strip 106 and negative switch arm 101. The magnet 32 being energized, the T-lever 30 is rotated about its pivot and operates the spark advancer for the engine E. The latter may now accelerate to full normal speed.

In order to prevent any of the clutches A, B, C or D from being operated to connect the engine E to the driven shaft before the brake has been released, the stop mechanism shown in Fig. 1A is provided. This mechanism comprises stops *s* and *s'* extending into the path of the controller lever, and adapted to be withdrawn by an electro-magnet 89. The latter is in a branch circuit in parallel with the brake magnet circuit from the junction 140' through conductor 141' and windings of the stop magnet 89 to the contact strip 105. It will be noted that the brake magnet 61, the stop magnet 89, and the magnets 31 and 32 for the spark advancer are all controlled by the automatic switch I. The movement of the controller lever onto the contacts 105, 106 will therefore have no effect on the mechanism until the speed of the engine E is sufficient to operate the automatic switch I. The stops prevent the controller lever at this time from being moved beyond the position shown in dotted lines. When the engine E has accelerated sufficiently to operate the switch I, the spark advancer is operated, the brake released, and the stop magnet energized to withdraw the stops *s* and *s'*. The movement of the controller lever may now be continued. As the switch arm 101 engages the contact 107, a circuit is closed through the magnet coil of the first clutch A. This circuit is traced from the positive pole of the battery, through conductors 115, 144, to one terminal of the magnet coil of the clutch A. From the opposite terminal, the circuit is completed through conductor 145, contact 107, switch arm 101, ring 112, and conductor 121. The clutch A is therefore operated to connect the countershaft 35, through the sprocket wheels 41 and 45, and sprocket chain 41, to the driven shaft 47, to operate the latter at slow speed. As the switch arm 101 engages the contact 108, a circuit is closed through the magnet coil of the clutch B. The latter is operated to connect the countershaft to the driven shaft for rotation at a higher speed, the circuit for the magnet A being broken as the circuit for the clutch B is completed. In like manner, the clutches C and D are operated in succession to further increase the speed of the driven shaft. When the switch lever 101 reaches the contact 111, a circuit is completed by way of conductors 115 and 144, to the magnet coil 73, and from thence through a conductor 146, contact 111, switch arm 101, and to the negative terminal of the battery. The magnet 73 being energized, operates the clutch comprising the member 40, thereby connecting the engine shaft 17 directly to the driven shaft 47. A rod 160 operated by the lever 71 when the magnet 73 is energized, moves the valve member 8 to central position, the slot 12 permitting such movement without interfering with the operation of the governor K. If the speed of the engine becomes excessive, the governor moves the valve beyond a central position and throttles the supply of fuel. Any desired intermediate speed may be maintained by holding the controller lever stationary in a corresponding position. As the controller lever is moved back toward initial position, the clutches D, C, B and A are successively operated to reduce the speed of the driven member. As the controller lever leaves the contacts 105 and 106, the brake magnet coil is deënergized and the brake applied. The circuit for the magnet 32 is broken and the spark advancing mechanism brought to initial position. When the controller lever is brought to initial position, the circuits leading from the battery M are opened and the mechanism brought to rest. If the controller lever is moved to the left from central position, the switch arms 101 and 102 engage the contact strips 103' and 103, respectively, thereby connecting the armature brushes 118 and 119, respectively, with the negative and positive terminals of the battery. The current through the armature being reversed, the motor will operate in the reverse direction. The various steps in the acceleration of the mechanism are substantially the same as those already described. It will be noted however, that when the switch arm 101 engages the contact strip 106', a circuit will be completed in this instance through the magnet coil 31, so that the spark advancer for the engine E will be operated in a direction corresponding to the reverse operation of the engine.

A switch 148 is provided for closing a circuit through the clutch magnet coil 95 independently of the switches H and I. This enables the operator to connect the two engines together, and maintain them connected independently of the speed of the engines. This may be desirable in case the auxiliary engine fails to operate properly, and it is desired to start the main engine by power supplied directly from the electric motor G. It is also sometimes desirable to run the auxiliary engine and motor G at the normal speed of the engine E. In this case, the machine G may act as a generator, and supply current to recharge the storage battery M. A potential switch 149 in the circuit of the storage battery is adapted to be opened by a magnet coil 150. The circuit for the coil 150 may be traced from the conductor 122 through conductors 125, 135, switch *c*, conductor 133, and coil 150 to the battery. The magnet 150 is designed to open the switch 149 when the storage battery has been charged to a predetermined voltage, thereby opening the armature circuit of the machine G. As the circuit for the potential switch magnet includes the switch *c*, the potential switch will always be closed when the engine A is not running, so that the machine G may always receive current to start the engine A. The battery M may be used to supply current to electric lamps 151, or other electro-responsive devices, which may be employed on boats, automobiles, or other appliances with which the present invention is used. In some cases, it may also be desirable to run the motor G and auxiliary engine A when the main engine E is at rest. To enable this to be done, a switch 152 is provided in the circuit which controls the magnetic clutch between the engines and the sparking mechanism of the main engine. By opening this switch, the motor and the auxiliary engine may be run continuously without affecting the main engine. This arrangement permits the auxiliary engine A to be used for running the machine G as a generator to charge the storage battery.

Fig. 11 shows a modified form of connection between the auxiliary and main engines. In this arrangement, speed reducing gearing is employed, comprising a driving pinion 155 on the shaft of the auxiliary engine, and meshing with a gear wheel 156 on a shaft 157 in alinement with the main engine shaft 17. The magnetic clutch member 93 is carried by the shaft 157. With this arrangement, the auxiliary engine will be run at a much higher speed as compared with the main engine.

The present invention is adapted for use in many installations, such as railway trains, elevators, motor-boats, automobiles, trucks, and other appliances, where explosive engines might be employed, and owing to the simplicity and ease with which the engine may be controlled, the invention is adapted for a large field of uses where heretofore it has been impractical or impossible to employ explosive engines.

Although a storage battery is employed to supply power for operating the generator G, any other convenient source of electrical power might be utilized. The storage battery, however, when charged, is sufficient to effect the starting of the auxiliary explosive engine; and as this battery may be recharged by power supplied from either the main engine or the auxiliary engine, no other source of electric power is necessary. The storage battery may also serve to equalize the electric pressure for power or light which may be supplied from the machine G operating as a generator.

Although, for the purpose of illustration, a two-cycle engine is herein shown, there are many other forms of explosive engines which might be started and controlled in accordance with the principles of my invention, and it is within the province of mechanics skilled in the art to adapt the invention to many forms of engines. Other forms of transmission mechanism, magnetic clutches, etc., might be employed within the scope of this invention. I wish further not to be limited to the particular arrangements of parts or details of construction herein disclosed, as various changes might be made without departing from the spirit or scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The combination with internal combustion engines, each comprising a rotatable shaft, of means for connecting the engines through said shafts, means for starting one of the engines, and means for automatically disconnecting the engines when they have accelerated to a predetermined speed.

2. The combination with a main and an auxiliary internal combustion engine, means for starting the auxiliary engine, means for automatically connecting the engines when the auxiliary engine has attained a predetermined speed, and means for automatically disconnecting the engines when the main engine has accelerated to a predetermined speed.

3. The combination of an explosive engine, an auxiliary starting engine, an electromagnetic clutch for connecting the engines together, and means controlled by the speed of said explosive engine to automatically cause the operation of said clutch to disconnect the engines when the said explosive engine has attained sufficient speed to operate independently of the auxiliary engine.

4. The combination with an explosive engine, of an auxiliary starting engine, clutch mechanism for connecting the engines, means for automatically operating the clutch mechanism to connect the engines when the auxiliary engine has attained a predetermined speed, and means for automatically operating the clutch mechanism to disconnect the engines when said explosive engine has attained a predetermined speed.

5. The combination with a main explosive engine and an auxiliary starting engine, of clutch mechanism between the engines, electrical means operated by the auxiliary engine to effect the operation of the clutch

mechanism and connect the engines, and means operated by the main engine for effecting a disconnection of the engines.

6. The combination with a main explosive engine and an auxiliary starting engine, of an electro-magnetic clutch having its clutch members connected respectively to said engines, and switches controlling the magnetic clutch, said switches being controlled respectively by the speed of the two engines.

7. The combination with an explosive engine, of an auxiliary engine, an electro-magnetic clutch for connecting said engines, a switch in the electric circuit for said clutch, a speed governor operated by the auxiliary engine, and connections between said speed governor and switch for operating the latter when the auxiliary engine has accelerated to a predetermined speed.

8. The combination with a main explosive engine and an auxiliary starting engine, of an electro-magnetic clutch between the engines, a switch in the electric circuit for said clutch, a speed governor operated by the main engine, and connections between said governor and switch for operating the latter when the main engine reaches a predetermined speed.

9. The combination with a main engine and an auxiliary engine, of an electro-magnetic clutch between said engines, a switch in the circuit for the clutch magnet winding and open when the auxiliary engine is at rest, a speed governor connected to the auxiliary engine, connections between said governor and switch for closing the latter when the auxiliary engine reaches a predetermined speed, a second switch in said circuit and closed when the main engine is at rest, a governor connected to the main engine, and connections between said last named governor and switch for opening the latter when the main engine reaches a predetermined speed.

10. The combination with a main explosive engine and an auxiliary explosive engine, of a clutch between the engines, automatic means for operating the clutch to connect the engines, and automatic means for establishing a circuit for the sparking mechanism of the main engine when the engines are connected.

11. The combination with an internal combustion engine, of power transmission mechanism associated therewith, mechanism for controlling said power transmission mechanism, an auxiliary internal combustion engine, and means for operating said controlling mechanism by power generated by the auxiliary engine.

12. In combination, a main internal combustion engine, controlling apparatus therefor, an auxiliary internal combustion engine, connections between said engines for transmitting power for starting the main engine, and a generator driven by said auxiliary engine and supplying power for operating said controlling apparatus.

13. In combination, an internal combustion engine, a driven element, variable speed and power transmission mechanism between the engine and driven element, controlling apparatus for said mechanism, a second internal combustion engine operable to supply power directly to the first named engine to start the latter, and means operated by said second engine for generating power for operating said controlling apparatus.

14. The combination of an internal combustion engine, means for controlling the operation of the engine when running in either direction, a second internal combustion engine, means for connecting and disconnecting said engines, and means for starting said second engine in either direction, said means being operated by power generated by the second engine after it has reached a given speed.

15. The combination with an internal combustion engine, of an auxiliary internal combustion engine adapted to be connected thereto for starting the first named engine, and means located at a distance from the engines for controlling them by power generated by the auxiliary engine.

16. In combination, an internal combustion engine, a driven member, variable speed power transmission mechanism interposed between said engine and driven member, an auxiliary engine, devices for controlling said power transmission mechanism, devices for controlling the operation of said internal combustion engine, means for connecting said auxiliary engine to said internal combustion engine to start the latter, and means for utilizing and applying power generated by the auxiliary engine for operating said controlling devices.

17. The combination with main and auxiliary reversible explosive engines, means for starting the auxiliary engine in either direction, and means for coupling the engines together to start the main engine after the auxiliary engine has started.

18. The combination with main and auxiliary internal combustion engines, a reversible electric motor connected to the auxiliary engine and operable to start the latter in either direction, said electric motor being operable as a generator to generate current when running in either direction, and electro-receptive means to receive said current.

19. The combination with an internal combustion engine, of a driven member, an electro-magnetic brake therefor, electro-magnetic clutch mechanism interposed between the driven member and the engine, means for starting the engine, means for preventing the operation of the brake to release the driven member before the engine has

reached a predetermined speed, a manually operable device for controlling the circuits to the brake and clutch mechanism, and means to prevent said device from being operated into position to effect the operation of the clutch mechanism before the brake has been released.

20. The combination with a main and an auxiliary internal combustion engine, of clutch mechanism between the engines, means for automatically operating the clutch mechanism to disconnect the engines when the main engine has speeded up, and a manually operable device for rendering said last named means ineffective, whereby the engines may be run together at full speed.

21. The combination with an internal combustion engine, of an auxiliary engine, an electro-magnetic clutch between the engines, a switch in the electric circuit for the clutch magnet normally open when the auxiliary engine is at rest, means for closing said switch when the auxiliary engine has been accelerated to a given speed, a second switch in said circuit normally closed when the said internal combustion engine is at rest, means for opening said second switch and disconnecting the engines when said internal combustion engine has been accelerated to a predetermined speed, and a third switch controlling the clutch magnet circuit and operable to maintain said circuit independently of the speed of the engines.

22. The combination with a main internal combustion engine, of an auxiliary engine, an electric motor connected to the auxiliary engine, means for automatically connecting and disconnecting said engines, and a device for rendering said last named means ineffective.

23. The combination of an internal combustion engine, of an electro-dynamic machine mechanically connected thereto, a storage battery and circuits for supplying electric current from the battery to said machine to operate the latter as a motor and start the said engine, said engine being operable when accelerated to run said machine as a generator and return current to the storage battery to recharge the same, means for automatically disconnecting the battery from the generator when the battery has been recharged to a predetermined voltage, and a device controlled by the engine for rendering said disconnecting means ineffective while the engine is at rest.

24. The combination of a main explosive engine, a pilot explosive engine, each comprising a continuously rotatable member, means for connecting said members together, and means dependent upon the speed of the engines for automatically disconnecting them when the main explosive engine has attained sufficient speed to operate independently of the pilot engine.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

AUGUST SUNDH.

Witnesses:
THEODORE E. TERRELL,
BESSIE WATSON.