C. O. PEARSON.

ELECTRIC CONTROLLER FOR EXPLOSIVE ENGINES AND ASSOCIATED MECHANISMS.

APPLICATION FILED AUG. 17, 1908.

1,064,765. Patented June 17, 1913.

4 SHEETS—SHEET 1.

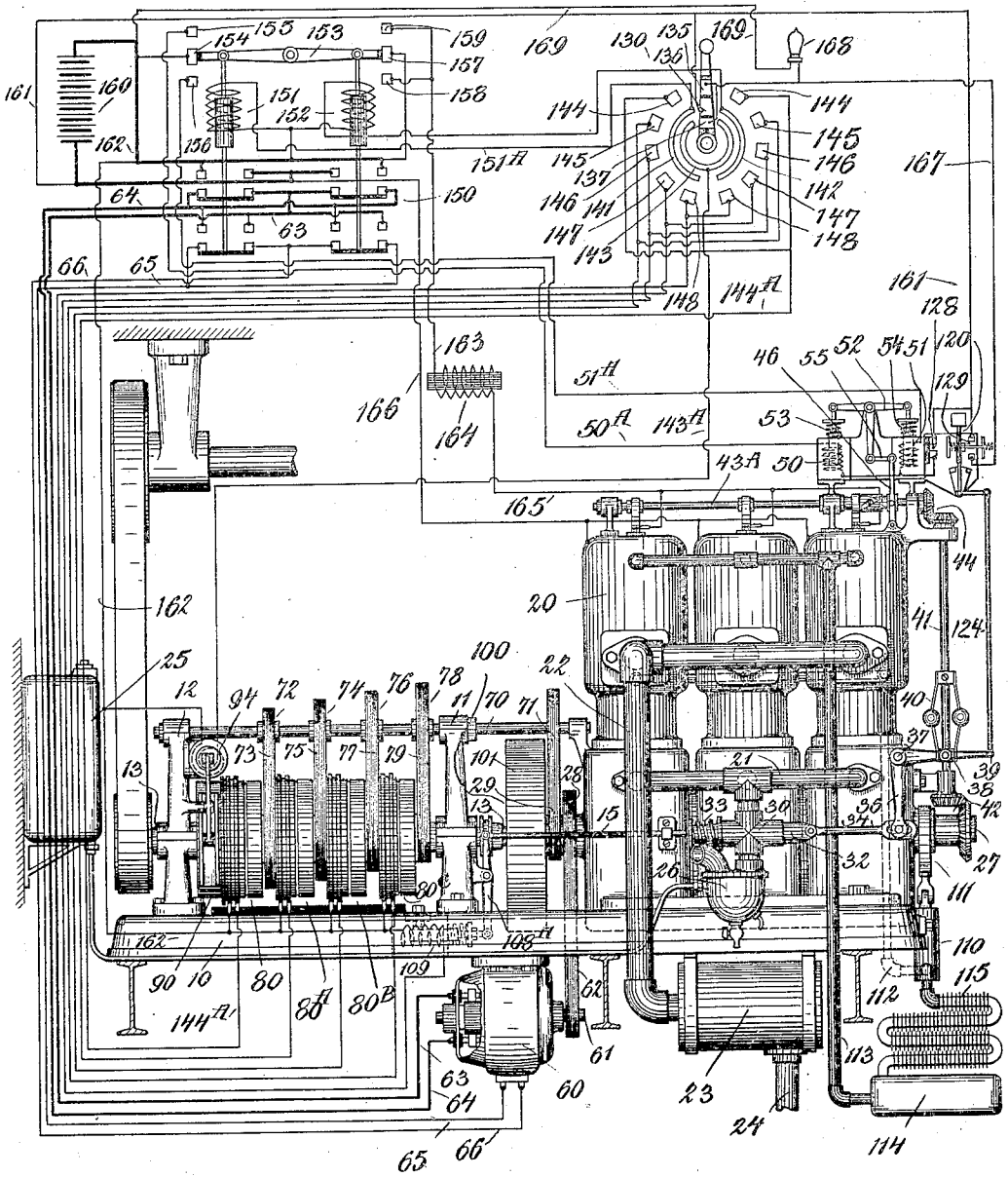

Fig. 1.

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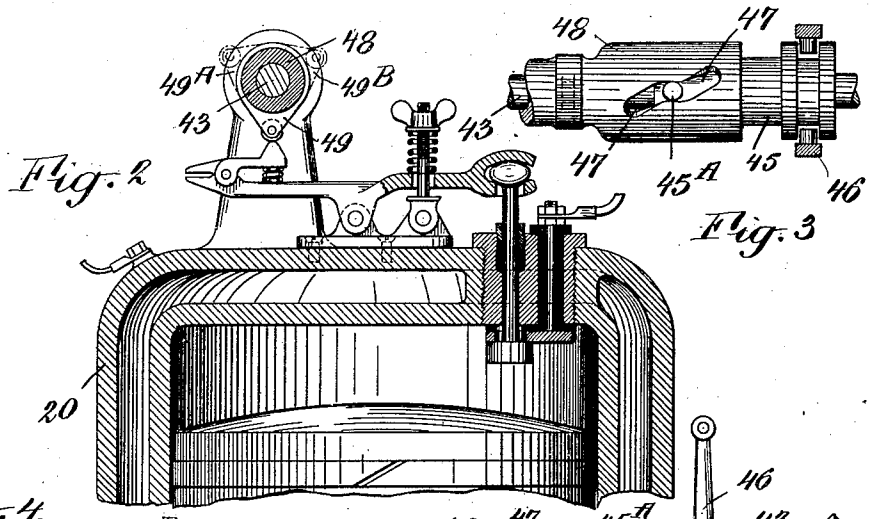

Fig. 2.

Fig. 3.

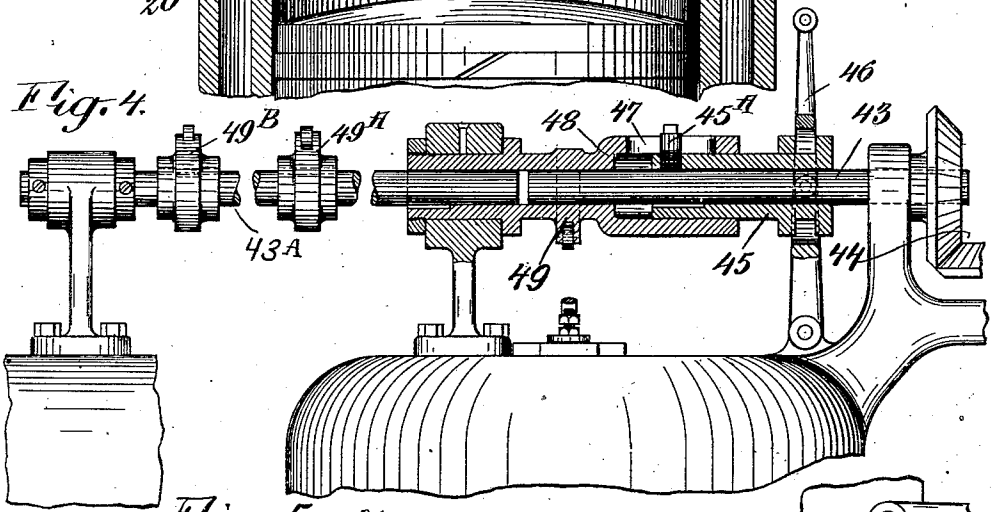

Fig. 4.

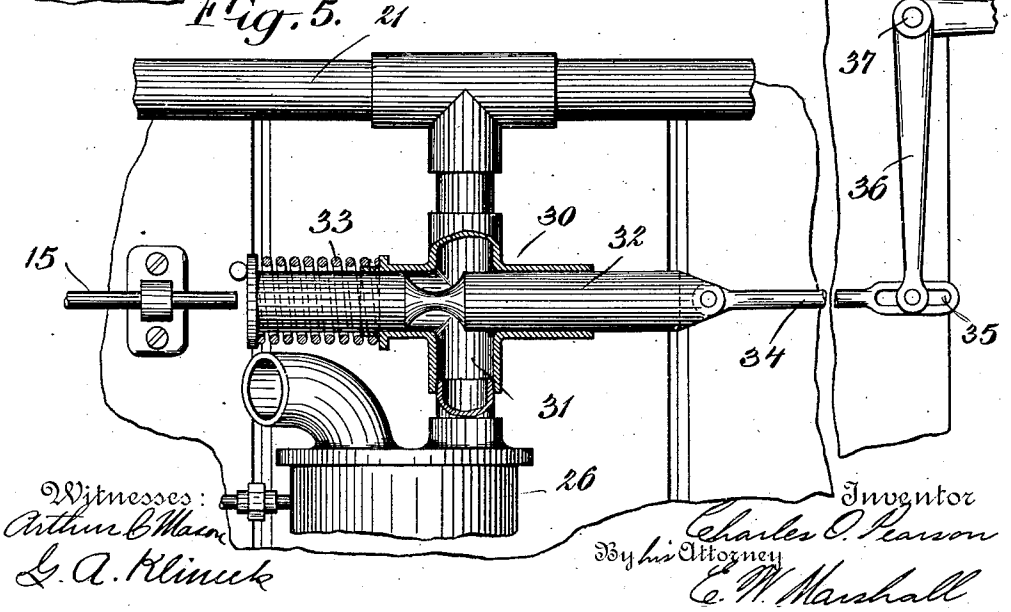

Fig. 5.

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4 SHEETS—SHEET 3.

Fig. 6.

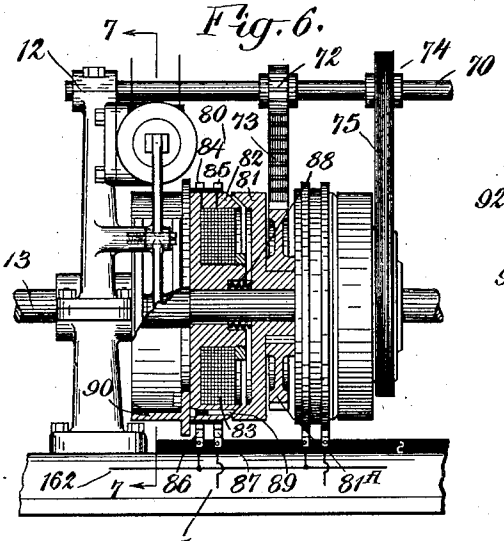


Fig. 7.

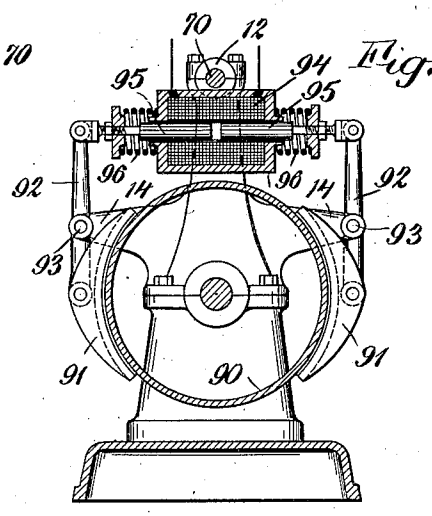


Fig. 8.

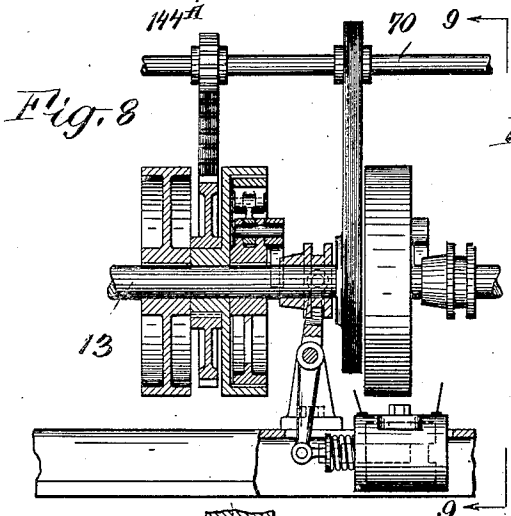


Fig. 9.

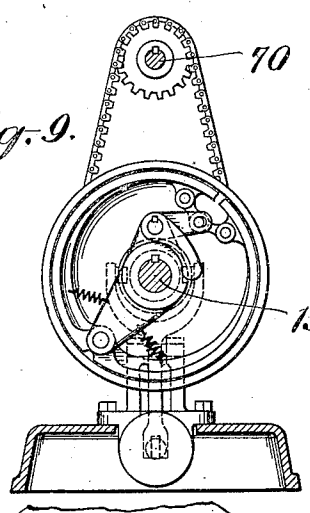


Fig. 10.

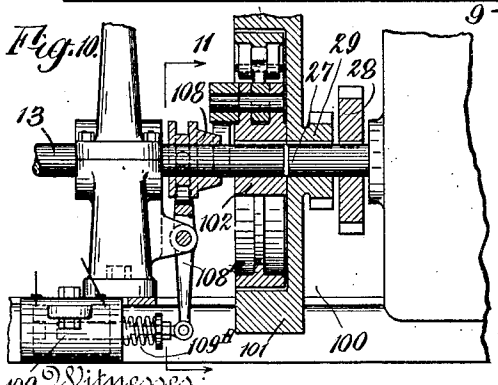
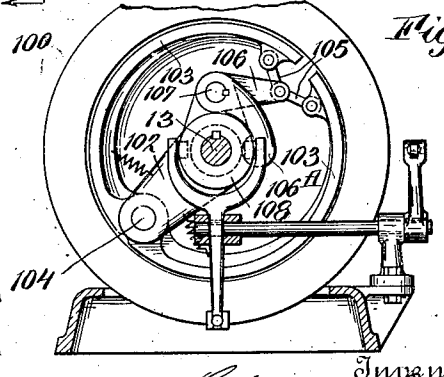


Fig. 11.



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4 SHEETS—SHEET 4.

Fig. 12.

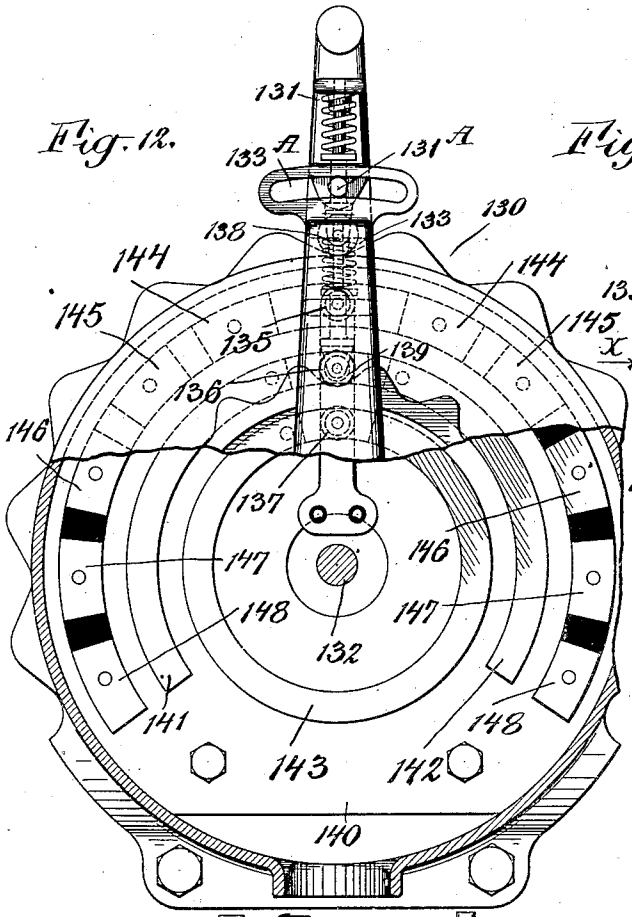


Fig. 13.

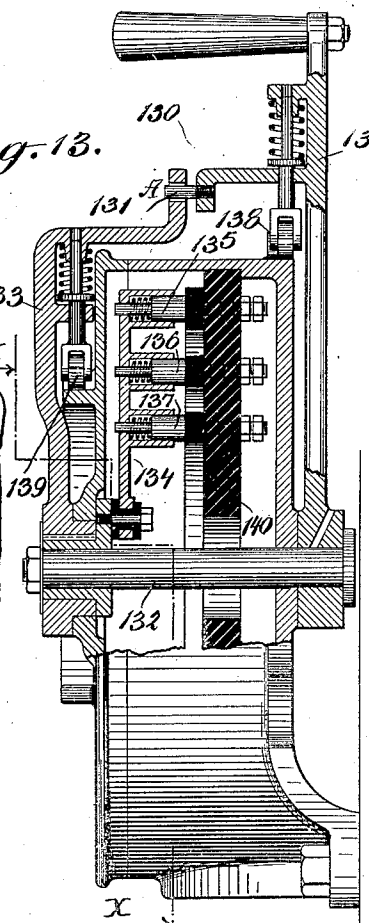


Fig. 15.

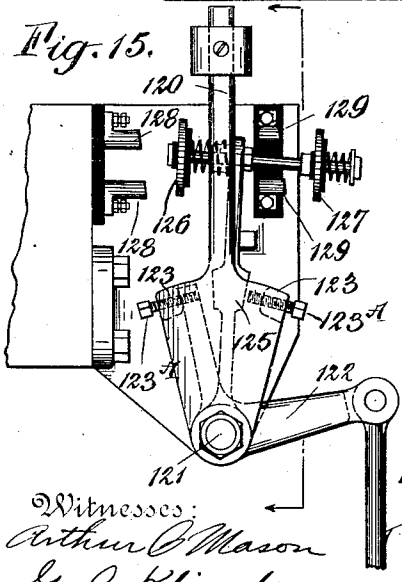


Fig. 16.

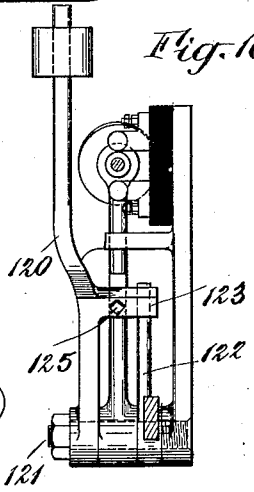
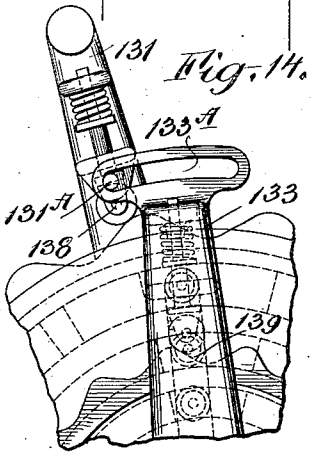


Fig. 14.



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UNITED STATES PATENT OFFICE.

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ELECTRIC CONTROLLER FOR EXPLOSIVE-ENGINES AND ASSOCIATED MECHANISMS.

1,064,765. Specification of Letters Patent. Patented June 17, 1913.

Application filed August 17, 1908. Serial No. 448,878.

To all whom it may concern:

Be it known that I, CHARLES O. PEARSON, a citizen of the United States, and a resident of the borough of Brooklyn, in the county of Kings, in the city and State of New York, United States of America, have invented certain new and useful Improvements in Electric Controllers for Explosive-Engines and Associated Mechanisms, of which the following is a specification.

My invention relates to improvements in controllers for internal combustion engines and associated power transmission mechanisms, and its object is to provide an electrical system by means of which engines of this type may be started, stopped, and reversed, and whereby the power generated by such engines may be transmitted to driven mechanisms at different speeds at will by means of a simple manually operated switch which may be placed in any convenient location. As will appear hereinafter the control of the power transmission device may be independent of the engine control, or both may be controlled together.

My invention consists in the construction and arrangement of parts which are described in the following specification and the novel features of which will be set forth in appended claims.

Referring to the drawings, Figure 1 is a side elevation of an internal combustion engine and associated mechanisms as used in carrying out my invention, together with certain connecting electrical circuits which are shown diagrammatically. Fig. 2 is a sectional end view on an enlarged scale of the top of one of the engine cylinders, showing somewhat in detail the sparking mechanism. Fig. 3 is a plan view of one of the details of the sparking mechanism. Fig. 4 is a fragmentary side elevation, partly in section, of the sparking mechanism. Fig. 5 is a side elevation, partly in section, of a throttle or regulating valve together with some of its connected parts. Fig. 6 is a side elevation, partly in section, showing a brake mechanism and some of the magnetic clutches which are used in carrying out the invention. Fig. 7 is a sectional end view of the brake mechanism, the section being taken through the line 7—7 of Fig. 6. Figs. 8 and 9 show in side elevation, partly in section, and in end elevation a modified form of clutch. Fig. 10 is a sectional side view of one of the clutches and its connected parts. Fig. 11 is an end view of the clutch shown in Fig. 10. Fig. 12 is a front elevation of a manually operated switch by means of which the various mechanisms herein described are controlled. A part of the switch is broken away on the line X—X of Fig. 13 to more clearly show its construction. Fig. 13 is a sectional side elevation of this switch. Fig. 14 is a front elevation of a part of the switch mechanism illustrating its operation. Figs. 15 and 16 are, respectively, front and side views of an electric switch of special construction which is used to control some of the circuits. The view shown in Fig. 16 is cut off on the section line shown in Fig. 15.

Like characters of reference designate corresponding parts in all of the figures.

10 designates a base upon which are mounted an internal combustion engine 20 and other mechanisms which will be described hereinafter. The engine may be of any preferred type or form. In the present case it is shown as a three-cylinder two-cycle gasolene engine of which 21 is the intake or supply pipe.

22 is a pipe from the outlet or exhaust the gases of which, after passing through a muffler 23, may be led off to a stack or chimney, or some other desired place by a pipe 24.

25 is a gasolene supply tank which is connected with a carbureter 26, and the latter is connected with the intake 21 of the engine through a regulating or throttle valve 30.

27 is the main shaft of engine 20.

The throttle valve 30 is shown somewhat in detail in Fig. 5. From this figure it may be seen that in the passage 31 between the carbureter 26 and the engine intake 21 is a piston valve 32. A compression spring 33 is arranged to hold this piston valve over to the left, in which direction it has a tendency to close the passage 31. 34 is a connecting rod between the other end of the piston valve and a downwardly projecting arm of a bell-crank lever 36 and connected with the latter by a slot connection 35 which allows a certain amount of lost motion. The bell-crank lever is pivoted to the engine frame at 37 and its other arm is connected at 38 with a centrifugal governor and at 39 with another device which will be described later.

The centrifugal governor 40 is mounted upon a vertical rod 41 which is driven by the engine shaft 27 through bevel gears 42 and

arranged to actuate a shaft 43 of the sparking mechanism.

44 are gears connecting the rod 41 and the shaft 43. 45 is a sleeve arranged to rotate with this shaft 43 but arranged to be moved longitudinally thereon by means of a lever 46. This sleeve carries a pin 45A which projects through a slot 47 in another sleeve 48. The slot is of some such shape as that shown in Fig. 3. The sleeve 48 carries a cam 49 which is arranged to actuate a sparking mechanism such as that shown in Fig. 2 for one of the engine cylinders, and is connected with a shaft 43A to which are affixed other cams 49A and 49B which actuate similar sparking mechanisms for the other cylinders. As this mechanism is well known in the art and is not a part of the present invention I will not further describe it.

50 and 51 are magnets acting upon a T-shaped lever 52 against the action of springs 53, 54. The lower end of the lever 52 is connected by a link 55 with the upper end of the lever 46. By this means the lever 46 may be shifted to move the sleeve 45 back and forth on the shaft 43.

60 is an electrodynamic machine which may be mounted upon the base 10 and which is connected with the engine shaft 27 by a sprocket chain 62 running over a sprocket-wheel 28 keyed to the engine shaft and over a similar wheel on its own shaft 61. 63 and 64 designate the leads from the armature of this machine 60, and 65, 66 the leads from its field winding. It is evident that this machine will always run with the engine. It sometimes acts as a motor and sometimes as a generator as will appear more fully hereinafter.

70 is a countershaft supported by pedestals 11 and 12 which are upon the base 10 and arranged to be positively driven from the engine shaft 27 by means of a sprocket-chain 71 running over a sprocket-wheel 29 keyed to the engine shaft and over a similar wheel upon the shaft 70. The sprocket-wheel 29 may be an integral part of a member 101 which forms a fly-wheel for the engine and a part of a clutch as will appear hereinafter.

72, 74, 76 and 78 are sprocket-wheels of different sizes rigidly mounted upon the countershaft 70 and connected by sprocket-chains 73, 75, 77 and 79 to drive parts of magnetic clutches such as those shown somewhat in detail in Fig. 6. Each of the clutches such as 80 comprises a driving member such as 81 loosely mounted upon a power transmission shaft 13 and supporting a sprocket-wheel 81A which is keyed to the driving member and over which the sprocket-chain 73 runs. The driving member is rotated by countershaft 70 but as the sprocket-wheel 72 is much smaller in diameter than is the sprocket-wheel 81A, the speed will be greatly reduced through this connection. Facing this driving member and fast upon the shaft 13 is a driven member 82 of the clutch. Within this driven member is a winding or coil 83, and upon its outer periphery are mounted two contact rings 84 and 85 to which the terminals of coil 83 are connected. A pair of contact brushes 86 and 87 bear upon these rings 84 and 85.

88 is a compression spring between the driving and driven members which has a tendency to keep these members apart.

89 designates a graphite pencil which may be used for lubrication if desired.

It is evident that when a current is sent through the coil 83 the driven member will be magnetized thereby and this will draw the two members together. They are arranged to contact with each other near their outer peripheries so that they will be driven together and the shaft 13 will be rotated thereby from the countershaft at the speed of the sprocket-wheel 81A. The other clutches operate in the same way, but as their driving-wheels 74, 76, and 78 are of larger diameters, and the sprocket-wheels with which each is connected are of correspondingly smaller diameters, the speed at which the shaft 13 is driven will vary according to the particular clutch which is engaged.

90 is a brake pulley which is affixed to the driven member 82 so that it will rotate with the latter. 91, 91 are brake-shoes arranged to bear upon this brake-pulley. They are supported upon brake-levers 92, 92 which are pivoted at 93, 93 in arms 14 projecting from the pedestal 12.

94 designates an electromagnet or solenoid supported by the pedestal 12. It is provided with two cores 95, 95, one of which is connected with one of the brake-levers 92 and the other with the other brake-lever. Springs 96, 96 tend to push these cores apart and to apply the brake. When the brake solenoid is energized the cores are attracted to each other and the brake released thereby.

100 designates another clutch which is shown in Figs. 10 and 11. This is somewhat differently constructed. In this case the driving member 101 which I have already pointed out forms a fly-wheel on one side of which is the sprocket wheel 29. The driven member 102 which is affixed to the transmission shaft 13 carries upon it a pair of shoes 103, 103 which are pivoted to the body portion of the driven member 102 at 104. They are connected at their other ends by a pair of links 105 which are connected with a toggle-lever 106 pivoted in the body of the driven member at 107 and having a portion 106^a in alinement with the shaft 13. A wedge-shaped slidable collar 108 is arranged to engage with this toggle-lever, and through its connection with the shoes 103,

to press them outward into engagement with the inner surface of the driving member 101. The sleeve 108 is arranged to be moved longitudinally upon the shaft 13 by means of a pivoted lever 108A which is actuated in one direction by an electromagnet 109 to actuate the clutch, and in the opposite direction by a spring 109A to release the clutch.

In Figs. 8 and 9 I have shown clutches similar in construction to that which I have just described, which may be used if desired, upon the transmission shaft 13 in place of the form of clutch which I have shown in Fig. 6 and which I have above described.

110 designates a water supply pump which is actuated by an eccentric 111 upon the motor shaft 27. This pump is connected by a pipe 112 with the water jacket of the engine, and the water jacket is connected by a pipe 113 with a water supply tank 114. 115 designates cooling pipes between this water supply tank and the intake of the pump 110.

The switch shown in Figs. 15 and 16 comprises a weighted arm 120 pivoted at 121 which is actuated by a bell-crank lever 122 pivoted to the same point and arranged to engage with lugs 123, 123 on the arm 120. The bell-crank lever is connected by a rod 124 with the centrifugal governor mechanism at 39.

123A, 123A are adjustable screws in the lugs 123 which are arranged to engage with a switch-arm 125. This switch arm is also pivoted at 121 and carries contact plates 126 and 127 which are insulated from the arm and from each other. The contact plate 126 is arranged to bridge and connect a pair of stationary contacts 128, 128, and the contact plate 127 is arranged to bridge and connect a pair of stationary contacts 129, 129.

130 is a manually operated controlling switch. This comprises a hand lever 131 loosely mounted upon a shaft 132 and carries a pin 131A which projects through a slot 133A in an actuating arm 133 which is mounted upon shaft 132 and carries a switch arm 134 upon which are three brushes 135, 136 and 137.

138 designates a non-positive stop or holding device for the hand lever 131, and 139 is a similar device for the actuating arm 133 and the switch-arm 134. These holding devices coöperate with the cam surface upon the casing of the switch for the purpose of holding their respective parts in desired positions and to prevent the parts from stopping in intermediate positions.

The brushes 135, 136 and 137 are arranged to be moved onto the various stationary contacts, all of which are mounted upon an insulated base 140 and will be pointed out later in describing the operation of the invention.

150 is a reversing switch which comprises a plurality of coacting contacts and which is arranged to be actuated by electromagnets 151 and 152. Above the reversing switch and actuated by these magnets is a pivoted tilting lever 153 which is arranged to move a contact 154 against either one of stationary contacts 155 or 156, and a contact 157 against either one or the other of stationary contacts 158 and 159 at the same time.

160 is a storage battery which is connected with the various electrical apparatus above described by circuits which I will now point out and I will at the same time describe the operation of this controlling system which I have invented. The lower end of the battery is connected by conductor 161 with the brush 136, and when the operator moves this brush to the left onto a contact 141, a circuit is closed thereby by conductor 151A through magnet 151 and conductor 162 back to the battery. The left-hand portion of the reversing switch will be actuated thereby and will close circuits from the battery through both the armature and the field windings of the electrodynamic machine 60 in a given direction. This will then act as a motor and will drive the engine 20 through its mechanical connection therewith. The engine will draw in an explosive mixture which will be ignited by the spark mechanism previously described, and this mechanism and the engine will now be connected with the battery 160 through the spark coil in the following manner: When the left-hand side of reversing switch 150 is closed, the contact 157 on the tilting arm 153 which is connected with the upper terminal of the battery, is moved down against contact 158 which is connected by a conductor 163 with the spark coil 164, the other side of which is connected by conductor 165 with the contact points of the spark mechanisms. A conductor 166 connects the lower end of battery 160 with the frame of the engine. The engine will then begin to run itself and will drive the centrifugal governor 40. The latter will open the throttle valve 30, and as soon as sufficient speed is attained, it will push the weighted arm 120 over past its center of gravity, and this will in turn close a circuit through the contacts 128 and another circuit through the contacts 129. The conductor 161 from the lower end of the battery is connected with the upper contact 128 and the upper contact 129. the contact-plate 127 on switch arm 125 will now bridge the two contacts 129, 129. The conductor 167 is connected to the lower of these contacts and it will now be connected with the lower terminal of the battery. A signal lamp 168, situated near the hand-switch, is also connected with the conductor 167 and by a conductor 169 with the upper terminal

of the battery so that this lamp will indicate to the operator the closing of the switch which is controlled by the arm 120. The brush 137 will now be resting upon contact 143 which is connected by conductor 143A with the brake magnet 94, the other end of which is connected with the upper end of the battery by conductor 162. The brake will thereby be released so that the power transmission shaft 13 and the parts which it is arranged to drive will be free to be rotated. At the same time the circuits closed through contacts 128 will extend through magnet 50, conductor 50A, contacts 155 and 154 which are now closed, and through the latter with the upper terminal of the battery. This will cause the lever 46 to be shifted and the spark mechanism advanced by means of the mechanism which has been described. The engine will now come up to its full speed but will be prevented from racing by the speed governor which is so arranged that if the engine attains undue speed it will pull the throttle valve piston over past its central position and will thereby slow down the engine. The electrodynamic machine which acted as above described, as a motor for starting the engine, will now be driven by the engine and will generate current back into the storage battery 160. It is evident that if the hand controlling switch lever had been moved to the right instead of the left, similar operations to those above described would take place, but in this case the right-hand side of the reversing switch 150 would be closed and the connections would be made to the electrodynamic machine in such a way as to cause it to rotate in the opposite direction. Now, the circuit through the spark coil 164 will be closed through contacts 157 and 159, and the contact 154 will be brought down against contact 156 thereby closing a circuit through conductor 51A through the spark-control magnet 51, so that the spark will be shifted in the proper direction to increase the speed of the engine. The hand switch brush 135 will first rest upon one of the contacts 144 which are connected together, and by conductor 144A with the winding 83 of the magnetic clutch 80. This will close a circuit through winding 83 as the conductor 162 connects the battery with all of the clutches. The shaft 13 will then be driven by engine 20 through the countershaft 70 and the clutch 80. When the hand-switch is moved over until brush 135 rests upon contact 145, the clutch 80A, which is driven at a greater rate of speed, will be energized and the shaft 13 will be driven thereby at a correspondingly higher rate of speed. The brush 135 will be moved off from the contact 144 before it reaches contact 145, so that the clutch 80 will become deënergized as the clutch 80A becomes energized. The holding devices which were pointed out in connection with the hand-switch will positively insure this part of the operation, as the parts are so arranged that the brushes are moved quickly from one of their operative positions to the next, regardless of the rate of movement of the hand-lever, and cannot remain in intermediate positions. Similarly, the brush 135 may be moved onto contacts 146 and 147 to energize clutches 80B and 80C consecutively. When the switch is moved into its extreme position the brush 135 will rest upon contact 148, when it will energize the magnet 109 and thereby throw the clutch 100 into operation. This clutch is so arranged that it will directly couple the engine shaft 27 with the power transmission shaft 13 so that the latter will be driven at the full speed of the engine.

15 designates a push-rod which is connected with the upper end of lever 108A and is arranged to push against the end of the piston valve 32 of the throttle valve and to move the piston valve into its full open position, so that when the engine shaft is coupled with the power transmission shaft this arrangement will insure the engine being supplied with its full fuel capacity. The lost motion provided by the slot 35 in the end of bell-crank lever 36 will allow the push-rod 15 to perform this function without interfering with the action of the governor, but the governor connections are still operative so that if the engine exceeds its normal speed, the piston valve 32 will be pulled over past its center by the governor to keep the engine from racing.

By means of the invention herein disclosed an internal combustion engine may be readily controlled by a simple manipulation of an electric switch. By manipulating this switch the engine may be started, stopped, reversed, and its speed controlled; in fact the entire action of the engine may be controlled from this switch through the intermediary of the electromagnetically actuated devices which I have described. The difficult and dangerous practice of starting such an engine by cranking is done away with. The engine may be started and stopped at will, or it may be disconnected from the power transmission shaft without stopping the engine if desired. Devices are also provided for automatically governing the speed of the engine. The controlling switch may be placed wherever most convenient whether this be near the engine or at some remote place. This feature alone is of great value as it greatly enlarges the adaptability of the system. No skilled mechanic is needed to perform the simple operation necessary. This invention, therefore, removes many of the limitations which have heretofore been present with this

otherwise desirable and efficient type of motor. For these reasons it is believed that the appended claims should be entitled to a broad interpretation as they are intended to cover other constructions and arrangements than those which have been described herein merely as an illustration of one manner in which my invention may be carried into effect.

The electrodynamic machine is used to generate a supply of electrical energy which may then be used to run the electrodynamic machine as a motor to start the engine and may also be used to energize the control circuits. In this connection it is to be noted that intermediate pilot devices such as the reversing switch and the spark control magnets are used so that only a light current need be taken through the controlling switch so that the latter may be placed at any desired remote place and the current readily broken at its contacts. The engine may be started without a load and its action controlled as may also the driven mechanism, from a distant point.

The control system for the engine which is herein disclosed comprises means for starting the engine in either direction, governing its speed while running, and stopping the engine. When the action of any type of engine is to be controlled from a distance, it is important that all of these functions be under the control of the operator.

In a copending application for patent Serial No. 448,905 filed by Mr. August Sundh and myself, filed on the same date as the present application, the construction of the controlling switch and its relations to the time constant of the magnetic clutches are set forth more fully than they are in this case.

What I claim is—

1. A reversible internal combustion engine, a sparking device therefor, an electrodynamic machine driven by the engine and arranged to generate an electrical supply, a storage battery, a single manually controlled device for directing said electrical supply to cause said supply to energize the electrodynamic machine to start the engine in either direction and to connect and disconnect said electrical supply with and from the sparking device.

2. An internal combustion engine, an electrodynamic machine connected therewith and arranged to generate an electrical supply, a storage battery, circuits for said electrodynamic machine, a manually operated switch for controlling said circuits and causing the electrical supply to run the electrodynamic machine as a motor until the engine attains its speed, a spark-advancing means, circuits therefor, an automatic switch in said circuits, and a centrifugal governor driven by the engine and arranged to control the automatic switch to thereby increase the speed of the engine.

3. An internal combustion engine, a sparking device therefor, an electrodynamic machine driven by the engine and arranged to generate a supply of electrical energy, a manually operated switch, and an electrically actuated reversing switch controlled thereby and arranged to connect said battery with the electrodynamic machine to cause said supply to run the electrodynamic machine in either direction as a motor, said reversing switch being also arranged to control the supply to the sparking device.

4. An internal combustion engine, an electrodynamic machine driven thereby, electromagnetically actuated devices for controlling the starting, stopping and speed of the engine, a manual switch for controlling said devices, and a storage battery arranged to be charged from the electrodynamic machine and to supply current for the electromagnetically actuated devices and the manual switch.

5. A reversible internal combustion engine, an electrodynamic machine connected therewith and arranged to start the engine in either direction, an electrical control system for the engine comprising means for controlling the speed of the engine, said machine being arranged to generate an electrical supply for energizing the control system, a storage battery, and means for connecting the battery with the electrodynamic machine to charge the battery when said machine is running in either direction.

6. An internal combustion engine, a sparking device therefor, an electrodynamic machine driven by the engine and arranged to generate an electrical supply, a storage battery arranged to be connected with the electrodynamic machine, manual means, and electromagnetically actuated means controlled thereby for directing the electrical supply to cause said supply to energize the electrodynamic machine to start the engine and to connect and disconnect the battery with and from the sparking device.

7. A reversible internal combustion engine, a sparking device therefor, electromagnetic means energized by a current generated by the engine for shifting the sparking device in one direction when the engine is running in one directon, and for shifting the sparking device in the opposite direction when the engine is running in the other direction, and a manual switch for controlling said electromagnetic means.

8. An internal combustion engine, a sparking device therefor, an electrodynamic machine connected with the engine, said machine being arranged to start the engine and to generate a supply of electrical energy, electromagnetic means energized by said supply for shifting the sparking device, an

electromagnetically actuated switch for controlling the electrodynamic machine and said shifting means, and arranged to connect and disconnect said supply with and from the sparking device, and a manual switch for controlling said electromagnetically actuated switch.

9. An internal combustion engine, a sparking device therefor arranged to be shifted in one direction or the other, an electrodynamic machine connected with the engine, said machine being arranged to start the engine and to generate a supply of electrical energy, a storage battery, electromagnetic means energized by said supply for shifting the sparking device, an electromagnetically actuated reversing switch arranged to connect said electrical supply with the electrodynamic machine to cause said supply to run said machine in either direction as a motor, said reversing switch being also arranged to control the current supply to the sparking device and to control the electromagnetic spark-shifting mechanism, and a manually operated switch for controlling said electromagnetically actuated reversing switch.

10. An internal combustion engine, a driven member, an intermediate variable speed power transmission device mechanically driven by the engine, electrical means for connecting said member with the engine through said transmission device, and independent electrically controlled means for directly connecting said member with the engine.

11. An internal combustion engine, a driven member, an intermediate variable speed power transmission device mechanically driven by the engine, means for connecting said member with the engine through said transmission device, independent means for directly connecting said member with the engine, and means driven by the engine arranged to generate energy for actuating the transmission device connecting means and said independent connecting means.

12. An internal combustion engine, an electrodynamic machine driven thereby and arranged to generate a supply of electrical energy, a driven member, an intermediate variable speed power transmission device mechanically driven by the engine, and independent means for directly connecting said member with the engine, said power transmission device and said independent connecting means being controlled by said electrical supply.

13. An internal combustion engine, an electrodynamic machine driven thereby and arranged to generate a supply of electrical energy, a driven member, an intermediate variable speed power transmission device mechanically driven by the engine, independent means for directly connecting said member with the engine, and electrical means for controlling the power transmission device, the independent connecting means, and for controlling the engine.

14. An internal combustion engine, a driven shaft, an intermediate variable speed power transmission device mechanically driven by the engine, a plurality of clutches for connecting said shaft with the engine through the transmission device, an independent clutch for directly connecting said shaft with the engine, and a speed governor controlling said independent clutch and the speed of the engine.

15. An internal combustion engine, an electrodynamic machine connected therewith, a driven shaft, an intermediate variable speed power transmission device mechanically driven by the engine, a plurality of clutches for connecting said shaft with the engine through the transmission device, an independent clutch for directly connecting said shaft with the engine, means for controlling the electrodynamic machine and said clutches from a distance, and a speed governor controlling said independent clutch and the speed of the engine.

16. An internal combustion engine arranged to be run at a constant rate of speed in either direction, a driven shaft, an intermediate variable speed power transmission device mechanically driven by the engine, a plurality of clutches for connecting said shaft with the engine through said transmission device, an independent electrically controlled clutch for directly connecting said shaft with the engine; an electrodynamic machine connected with the engine and arranged to start the engine and to generate a supply of electrical energy, a storage battery, and a manual switch arranged to control the engine and said clutches from a distance.

17. An internal combustion engine arranged to be run at a constant rate of speed in either direction, a driven shaft, an intermediate variable speed power transmission device mechanically driven by the engine, a plurality of clutches for successively connecting said shaft with the engine through said transmission device, and to be driven thereby at increasing rates of speed, an independent electrically controlled clutch for directly connecting said shaft with the engine; an electrodynamic machine connected with the engine and arranged to start the engine and to generate a supply of electrical energy, a storage battery, and a manual switch arranged to control the engine and said clutches from a distance.

18. An internal combustion engine, an electrodynamic machine connected therewith and arranged to generate a supply of electrical energy, a driven member, a brake

therefor, an intermediate variable speed power transmission device mechanically driven by the engine, and means energized by said supply for actuating the brake and the power transmission device.

19. An internal combustion engine, an electrodynamic machine connected therewith and arranged to generate a supply of electrical energy, a driven member, an electromagnetically actuated brake therefor, an intermediate variable speed power transmission mechanism driven by the engine, independent means for connecting the driven member with the engine, and electrical means energized by said supply for actuating the brake, the power transmission mechanism and the independent connecting means.

20. An internal combustion engine, an electrodynamic machine connected therewith and arranged to generate a supply of electrical energy, a driven shaft, an electromagnetically actuated brake therefor, an intermediate variable speed power transmission device mechanically driven by the engine, a plurality of clutches for connecting the driven shaft with the engine through said transmission device, an independent clutch for directly connecting the driven shaft with the engine, means energized by said supply for actuating the brake and said clutches, and a manually operated switch for controlling said electrical means.

21. An internal combustion engine, an electrodynamic machine connected therewith and arranged to start the engine and to generate a supply of electrical energy, a driven shaft, an electromagnetically actuated brake therefor, an intermediate variable speed power transmission device mechanically driven by the engine, a plurality of clutches for connecting the driven shaft with the engine through said transmission device, an independent clutch for directly connecting the driven shaft with the engine, means energized by said supply for controlling the engine and for actuating the brake and said clutches, and a manually operated switch for controlling said electrical means from a distance.

22. An internal combustion engine, an electrodynamic machine connected therewith, said machine being arranged to generate a supply of electrical energy, a driven shaft, a power transmission device, electromagnetic clutches arranged to connect and disconnect said driven shaft with and from the engine, an electrically actuated brake for the driven shaft, said clutches and brake being actuated by the electrical supply, and an automatic switch arranged to actuated one of said clutches and to release the brake when the engine has reached a predetermined speed.

23. An internal combustion engine, an electrodynamic machine connected therewith, said machine being arranged to generate a supply of electrical energy, a driven member, a power transmission device, an electromagnetic clutch arranged to connect and disconnect said member with and from the transmission device, an electromagnetically actuated brake for the driven member, said clutch and brake being actuated by said electrical supply, an automatic switch arranged to throw in the clutch and to release the brake when the engine has reached a predetermined speed, and a manually operated switch for controlling the electrodynamic machine, the clutch, and the brake.

24. An internal combustion engine arranged to run at a constant rate of speed, an electrodynamic machine connected therewith, said machine being arranged to generate a supply of electrical energy, a driven shaft, a power transmission device, a plurality of electromagnetic clutches arranged to connect and disconnect the driven shaft with and from the transmission device and to change the speed thereof, an independent clutch arranged to connect and disconnect the driven shaft with and from the engine, said clutches being actuated by the electrical supply, a manually operated switch having a plurality of operative positions, and means for holding the switch in said positions, and connections between the switch and the clutches for controlling the clutches and causing them to be successively energized.

25. An internal combustion engine arranged to run at a constant rate of speed, an electrodynamic machine connected therewith, said machine being arranged to start the engine and to generate a supply of electrical energy, a reversing switch for controlling the electrodynamic machine, a driven shaft, a power transmission device, a plurality of electromagnetic clutches arranged to connect and disconnect the driven shaft with and from said transmission device and to change the speed thereof, an independent clutch arranged to connect and disconnect the driven shaft with and from the engine, an electromagnetically actuated brake, said clutches and brake being actuated by said electrical supply; and a manually operated switch having a plurality of operative positions and means for holding the switch in said operative positions, said switch being arranged to control the reversing switch, the clutches, and the brake.

26. An internal combustion engine, a throttle valve therefor, a driven member, an intermediate variable speed power transmission device mechanically driven by the engine, electrical means for connecting said member with the engine through said transmission device, and independent electrically controlled means for directly connecting said member with the engine and actuating said throttle valve.

27. An internal combustion engine, a throttle valve therefor, an electrodynamic machine connected with the engine, said machine being arranged to generate a supply of electrical energy, a driven shaft, a power transmission device, a plurality of electromagnetic clutches arranged to connect and disconnect the driven shaft with and from said transmission device and to change the speed thereof, an independent clutch arranged to connect and disconnect the driven shaft with and from the engine, said clutches being actuated by the electrical supply, and a mechanical connection between said independent clutch and the throttle valve arranged to open said throttle valve when said shaft is directly connected with the engine.

28. An internal combustion engine, a throttle valve therefor, an electrodynamic machine connected with the engine, said machine being arranged to generate a supply of electrical energy, a driven shaft, a power transmission device, a plurality of electromagnetic clutches arranged to connect and disconnect the driven shaft with and from said transmission device and to change the speed thereof, an independent clutch arranged to connect and disconnect the driven shaft with and from the engine, said clutches being actuated by the electrical supply, a mechanical connection between said independent clutch and the throttle valve arranged to open said throttle valve when said shaft is directly connected with the engine, and a manually operated switch for successively energizing said clutches.

29. An internal combustion engine, a throttle valve for the engine, a centrifugal governor connected with the throttle valve, an electrodynamic machine connected with the engine, said machine being arranged to start the engine and to generate a supply of electrical energy, electromagnetic mechanism energized by said supply for shifting the sparking device, a reversing switch arranged to connect said electrical supply with the electrodynamic machine to cause said supply to run the electrodynamic machine in either direction as a motor, said reversing switch being also arranged to control the current supply to the sparking device and controlling the electromagnetic spark-shifting mechanism; a driven shaft, an intermediate variable speed power transmission device mechanically driven by the engine, a plurality of electromagnetic clutches arranged to connect and disconnect the driven shaft with and from said transmission device and to change the speed thereof, an independent electromagnetically actuated clutch arranged to connect and disconnect the driven shaft with and from the engine, an electromagnetically actuated brake for the driven shaft, said clutches and brake being actuated by the electrical supply; a manually operated switch having a plurality of operative positions and means for holding the switch in said operative positions, said switch being arrranged to control the reversing switch, the spark-shifting mechanism, and the brake, and to successively energize the clutches, and a mechanical connection between said independent clutch and the throttle valve arranged to open said throttle valve when the independent clutch is energized.

30. An internal combustion engine, a power transmission device comprising a plurality of clutches, an electric control sytem for the engine and the transmission device, a manually operated circuit-closer, circuits therefor, and a speed governor driven by the engine and arranged to control said circuits.

31. An internal combustion engine, a driven member, an intermediate variable speed power transmission device mechanically driven by the engine, a control system for the engine and the power transmission device, a manually operated circuit-closer therefor, and a speed governor arranged to prevent the driven member being connected with the engine until the engine has reached a desired speed.

32. An internal combustion engine, a sparking mechanism therefor, electromagnetically actuated means for shifting the mechanism to increase the speed of the engine, and a speed governor arranged to prevent the shifting of the sparking mechanism until the engine has reached a desired speed.

33. An internal combustion engine, a driven member driven by the engine, a sparking mechanism for the engine, electromagnetic means for shifting said mechanism to increase the speed of the engine, a control system for the engine, a manually operated circuit-closer for said system, means for preventing said driving of the driven member and for preventing the operation of said electromagnetic means, and a speed governor arranged to cut out said preventing means when the engine has reached a desired speed.

34. An internal combustion engine, a member arranged to be connected with the engine to be driven thereby, a brake for said member, means to release the brake, a sparking mechanism for the engine, electromagnetic means for shifting said mechanism to increase the speed of the engine, an electric control system for the engine, a manually operated circuit-closer for said system, means for preventing said connection of the driven member with the engine, the operation of said electromagnetic means and the operation of said brake releasing means, and a speed governor arranged to cut out said preventing means when the engine has reached a desired speed.

35. An internal combustion engine, a driven member, a brake for said member, an

electric control system for the engine, the driven member, and the brake, a manually operated circuit-closer for said system, and a speed governor arranged to prevent the brake being released until the engine has reached a desired speed.

36. An internal combustion engine, a member arranged to be driven thereby, a clutch for connecting said member with the engine, a control system for the engine and the clutch, a manually operated circuit-closer therefor, and a speed governor arranged to prevent the clutch from connecting said member with the engine until the engine has reached a desired speed.

37. An internal combustion engine, a member arranged to be driven thereby, a clutch for connecting said member with the engine, means for increasing the speed of the engine, a control system for the engine and the clutch, a manually operated circuit-closer therefor, and a speed governor arranged to cause the clutch to connect said member with the engine and to actuate the speed-increasing means when the engine has reached a desired speed.

38. An internal combustion engine, a member arranged to be driven thereby, a clutch for connecting said member with the engine, a fuel supply, means for regulating the admission of the fuel to the engine, and a speed governor arranged to prevent said clutch from connecting said member with the engine until the engine has reached a desired speed, and to open said fuel supply regulating means when the clutch is actuated to connect the member and the clutch together.

39. An internal combustion engine, a member arranged to be driven thereby, a brake for said member, a clutch for connecting said member with the engine, a fuel supply, means for regulating the admission of the fuel to the engine, and a speed governor arranged to prevent said clutch from connecting the member with the engine and the brake being released until the engine has reached a desired speed, and to cause the brake to release and to open said fuel supply regulating means when the clutch is actuated to connect said member and the engine together.

40. An internal combustion engine, a member arranged to be driven thereby, a brake for said member, a clutch for connecting said member with the engine, a sparking mechanism for the engine, means for shifting the sparking mechanism to increase the speed of the engine, a fuel supply, means for regulating the admission of the fuel to the engine, and a speed governor arranged to prevent the actuation of the brake, the clutch, the spark-shifting mechanism, and the full opening of the fuel regulating means until the engine has reached a desired speed.

41. An internal combustion engine, a member arranged to be driven thereby, an electromagnetically actuated brake for said member, an electromagnetically actuated clutch for connecting said member with the engine, a sparking mechanism for the engine, electromagnetic means for shifting the sparking mechanism to increase the speed of the engine, a fuel supply, means for regulating the admission of the fuel to the engine, an electric control system for starting the engine and for controlling the engine and the driven member, and a speed governor arranged to prevent the actuation of the brake, the clutch, the spark-shifting mechanism, and the full opening of the fuel regulating means until the engine has reached a desired speed, and to cause the brake to be released, the clutch energized, the sparking mechanism shifted, and the fuel regulating means opened simultaneously.

42. An internal combustion engine, a member arranged to be driven thereby, an electric control system for the engine and the driven mechanism, and a single manually operated circuit-closer arranged to control the engine control system and to separately control the driven mechanism.

43. An internal combustion engine, an electrodynamic machine driven thereby and arranged to generate a supply of electrical energy, a variable speed power transmission device comprising a plurality of electromagnetic clutches, an electrical control system for the engine and the transmission device, and a manually operated circuit-closer whereby the engine may be started and controlled and said clutches controlled from a distance by the electrical supply.

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

CHARLES O. PEARSON.

Witnesses:
ERNEST W. MARSHALL,
ELLA TUCH.