May 31, 1938. M. J. FINNEGAN ET AL 2,119,156

POWER PLANT

Filed Nov. 13, 1936

Fig. 1

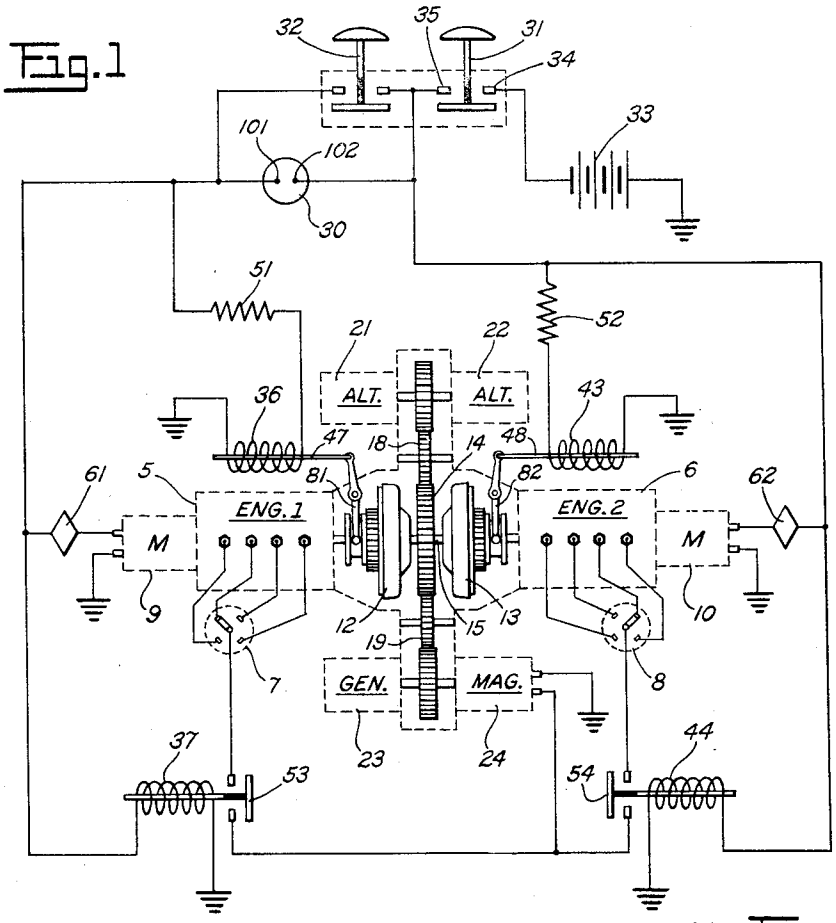
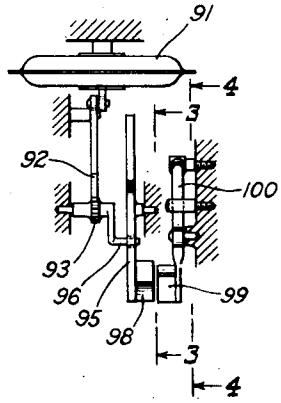


Fig. 2



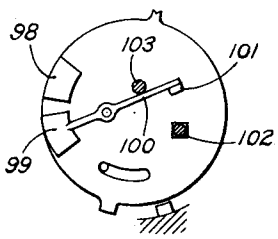
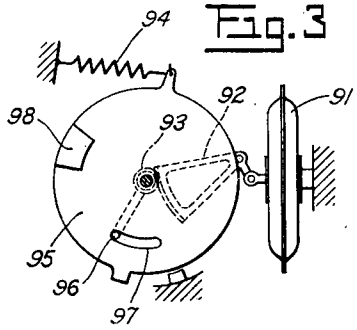


Fig. 4

Fig. 3



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2,119,156

POWER PLANT

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10 Claims. (Cl. 290—4)

This invention relates to power plants and particularly to a power plant involving the provision of two or more distinct prime movers adapted for selective application to a single mechanism to be driven, whereby the power for operating such mechanism to be driven may be taken from one or both of a pair of internal combustion engines, at the selection of an operator, or in accordance with the density of the atmosphere from which the prime movers happen to be drawing the air for combustion of the fuel charge.

When the invention is applied to a pair of engines carried by an aircraft, it will produce automatic cutting in and out of the second of the two engines, in accordance with variations in the altitude attained by the craft.

An object of the invention is to provide, in a system of the foregoing character, novel means for controlling the successive starting of the two engines to be successively applied to the mechanism to be driven, as well as the successive coupling operations themselves.

A further object of the invention is to provide in a system of the foregoing character a single source of energy to ignite the fuel charge of either of the engines together with novel unitary control means whereby the ignition is automatically caused to occur in properly timed relationship in each of the engines to which the driven mechanism is coupled, and preferably as an incidental operation to the act of so coupling the successively energized engines thereto.

Other objects and features of the invention reside in the specific construction and relationships of the elements and sub-combinations entering into the complete system as will become apparent upon analysis of the following specification when considered in its relation to the accompanying drawing illustrating one embodiment of the invention.

It is to be expressly understood, however, that the drawing is for the purpose of illustration only, and is not designed as a definition of the limits of the invention, reference being had to the appended claims for this purpose.

In the drawing:—

Fig. 1 is a schematic representation of the invention applied to a power plant including a pair of successively energizable internal combustion engines and a single combination of elements to be driven therefrom;

Fig. 2 is a view in elevation of the altitude controlled switch; and

Figs. 3 and 4 are transverse views along lines 3—3 and 4—4, respectively, in Fig. 2.

Referring first to Fig. 1, the two internal combustion engines are represented therein at 5 and 6, and each is shown as provided with an ignition current distributor and a starting motor, the distributors being shown at 7 and 8 and starting motors at 9 and 10 for the engines 5 and 6 respectively. Interposed between the two engines is a gear 14 rotatable with a shaft 15 projecting from opposite sides thereof and adapted to be driven by either of the clutch mechanisms 12 and 13, and in turn adapted to transmit rotation to a plurality of current generating units or other accessories to be driven through intervening gear trains as indicated at 18 and 19. Included among these generating units (indicated by the reference characters 21, 22, 23 and 24) is a magneto 24 constituting a source of ignition current to be distributed through one or both the distributors 7 and 8 in accordance with the conditions hereinafter more fully explained. The selection may occur manually, or automatically in response to closure of the proper switch or combination of switches 30, 31, and 32. When the switch 31 is moved in an upward (closing) direction, current is caused to flow from the battery 33 through the contacts 34 and 35 of the switch 31 to cause energization of the electromagnetic devices 43, 44 and 10, the latter being the electric motor for starting the engine 6 as heretofore indicated. Closure of the switch 30 or 32 (with switch 31 remaining closed) would cause current to flow from the source 33 through the switches 31 and 30 (or 32) in series, to energize the corresponding electromagnetic devices 36, 37 and 9 associated with the engine 5. The electromagnetic devices 36 and 43 are shown as solenoids controlling the operation of the clutch mechanisms 12 and 13, respectively, through the agency of shifter mechanisms 81 and 82 operatively connected to the ends of the solenoid plungers 47 and 48 respectively. In order to delay the operation of the clutch mechanisms for a brief interval sufficient to permit the engine to acquire some speed, there is preferably interposed in the circuits of the solenoids 36 and 43 resistor units as indicated at 51 and 52, respectively, whereby solenoids 36 and 43 do not become fully magnetized as readily as do the solenoids 37 and 44, the latter being in direct shunt relationship to the windings of the motors 9 and 10 respectively and hence operative to close the switch 53 or 54, as the case may be, promptly in response to flow of current thereto, thus assuring that the associated engine will be provided with ignition current as soon as the crankshaft begins to turn under the influ-

ence of the energization of the starter motor 8 or 10. Upon restoration of the switch 31 to its normal position consequent deenergization of solenoids 36 and 37, as well as 43 and 44, will likewise cause the return of the solenoid plungers and associated mechanism to their original positions due to the action of the conventional normalizing springs (not shown) thereupon.

As soon as the engine develops sufficient power so that its crankshaft runs in excess of the speed of the starting gear the latter may be thrown to the inoperative position by the well-known overrunning action, assuming the use of some such starting mechanism as that known as the Bendix drive; and by using a centrifugal switch such as is indicated in Fig. 2 of the Ertz Patent No. 1,940,712, the circuit to the electric motor may be interrupted by the action of such speed responsive switch (indicated diagrammatically at 61 for the motor 9 and at 62 for the motor 10), the setting of these speed responsive switches being such that they are normally closed and moved to the open position only when the engine crankshaft acquires a speed approximately corresponding to its normal running speed. It will be noted that the branch circuit to the motor is the only one interrupted in this fashion, the other circuits controlled by the switch 31 remaining closed so long as it is desired to maintain the driven units 21 to 24 in operation. The clutch 12—and the following is also true of clutch 13—is preferably of a character which functions normally as a positive, non-slipping clutch but initially as a slipping or friction clutch adapted to permit gradual picking up of the load; the elements constituting the normal path of torque transmission being a pair of gears or jaw clutch elements such as the jaw clutch elements designated by reference characters 10 and 11 in the drawings of Patent No. 1,991,112 granted February 12, 1935 to Romeo M. Nardone. Such clutch elements have their meshable teeth so disposed in relation to the driving and driven shafts that driving engagement of the clutch is possible only when the said driving and driven shafts are in predetermined relative angular positions, thus assuring maintenance of proper timing relationship between the engine crank-shaft and the rotor of the magneto 24, to the end that the igniting spark shall always occur at the predetermined piston positions.

If the power plant shown in Fig. 1 is installed on an aircraft to furnish the power for operation of current generating units 21, 22 and 23, the single engine 6 may be of sufficient capacity to maintain these units fully energized at the lower flying altitudes; but as the craft goes to a higher altitude the falling off in power output may be so substantial as to necessitate assistance from engine 5 in order to maintain the units at normal capacity. During such ascent aneroid 91 (Figs. 2 and 3) will have been operative to swing sector 92 upward and rotate pinion 93 in a counter-clockwise direction, thus permitting spring 94 to rotate disc 95 to the extent of movement of the pin 96 (moving with pinion 93) in slot 97 of disc 95. Moving with disc 95 is a magnet 98 designed to exert a magnetic attraction upon magnet 99 when moved sufficiently close thereto; whereupon contact arm 100, with which magnet 99 is integrated, will be swung sharply in the clock-wise direction, as viewed in Fig. 4, to cause closure of contact 101 upon contact 102, constituting the switch 30 of Fig. 1. A stop 103 limits movement of arm 100 as the craft descends.

What is claimed is:—

1. The combination with a plurality of internal combustion engines, each having an ignition current distributor and starting motor associated therewith, of an ignition current supply device common to said engines, means for causing the starting of one of said engines, and by the same action electrically connecting said ignition current supply device to the distributor of the engine to be started, said means comprising electrical conductors controlling energization of both the starting motor and the distributor for each engine, and pressure responsive means for controlling current flow to one of said starting motors and distributors, but not to the other.

2. The combination with a plurality of internal combustion engines, each having an ignition current distributor and starting motor associated therewith, of an ignition current supply device common to said engines, means for causing the starting of one of said engines, and by the same action electrically connecting said ignition current supply device to the distributor of the engine to be started, said means comprising electrical conductors controlling energization of both the starting motor and the distributor for each engine, electromagnetic means for causing the coupling of each engine to said ignition current supply device, to rotate the latter and thereby cause it to generate ignition current, and means in circuit with said electrical conductors for energizing said electromagnetic means.

3. The combination with a plurality of internal combustion engines, each having an ignition current distributor and starting motor associated therewith, of an ignition current supply device common to said engines, means for causing the starting of one of said engines, and by the same action electrically connecting said ignition current supply device to the distributor of the engine to be started, said means comprising electrical conductors controlling energization of both the starting motor and the distributor for each engine, and speed responsive means for interrupting the current flow to the starting motor.

4. The combination with a plurality of internal combustion engines, each having an ignition current distributor and starting motor associated therewith, of an ignition current supply device common to said engines, means for causing the starting of one of said engines, and by the same action electrically connecting said ignition current supply device to the distributor of the engine to be started, said means comprising electrical conductors controlling energization of both the starting motor and the distributor for each engine, electromagnetic means for causing the coupling of each engine to said ignition current supply device, to rotate the latter and thereby cause it to generate ignition current, and means in circuit with said electrical conductors for energizing said electromagnetic means, said coupling means including clutch elements meshable only when the crankshaft is in a predetermined angular position with respect to said ignition current supply means.

5. The combination with a plurality of internal combustion engines, each having a starting motor associated therewith, of means comprising electrical conductors for controlling energization of said starting motors, and pressure responsive means for controlling current flow to one of said starting motors but not to the other.

6. The combination with a plurality of internal combustion engines, each having an ignition

current distributor associated therewith, of an ignition current supply device common to said engines, means for electrically connecting said ignition current supply device to said distributors said means comprising electrical conductors for controlling energization of the distributors, and pressure responsive means for controlling current flow to one of said distributors but not to the other.

7. The combination with a plurality of internal combustion engines, each having an ignition current distributor and starting motor associated therewith, of an ignition current supply device common to said engines, means for causing the starting of a selected one of said engines, and by the same action electrically connecting said ignition current supply device to the distributor of the selected engine, said means comprising electrical conductors controlling energization of both the starting motor and the distributor for each engine, and aneroid actuated means for controlling current flow to one of said starting motors and distributors, but not to the other.

8. The combination with a plurality of internal combustion engines, each having a starting motor associated therewith, of means comprising electrical conductors for controlling energization of said starting motors, and aneroid actuated means for controlling current flow to one of said starting motors but not to the other.

9. The combination with a plurality of internal combustion engines, each having an ignition current distributor associated therewith, of an ignition current supply device common to said engines, means for electrically connecting said ignition current supply device to said distributors said means comprising electrical conductors for controlling energization of the distributors, and aneroid actuated means for controlling current flow to one of said distributors but not to the other.

10. The combination with a plurality of internal combustion engines, each having a starting motor associated therewith, of means comprising energy conductors for controlling energization of said starting motors, and aneroid actuated means for controlling energy flow through one of said conductors but not the other.

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