Aug. 8, 1939. L. J. ADAMS ET AL 2,168,927

PRIME MOVER REGULATION

Original Filed Oct. 22, 1937

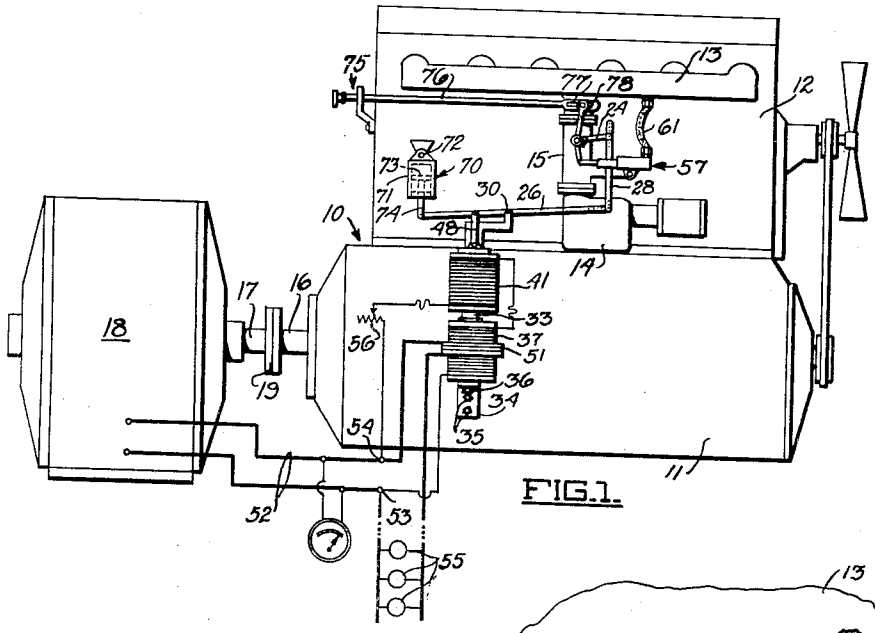


FIG. 1.

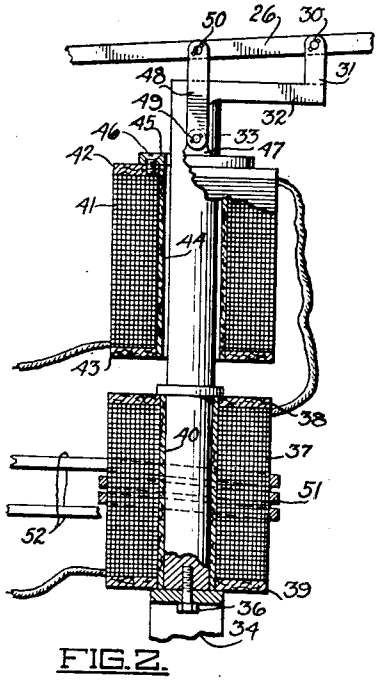


FIG. 2.

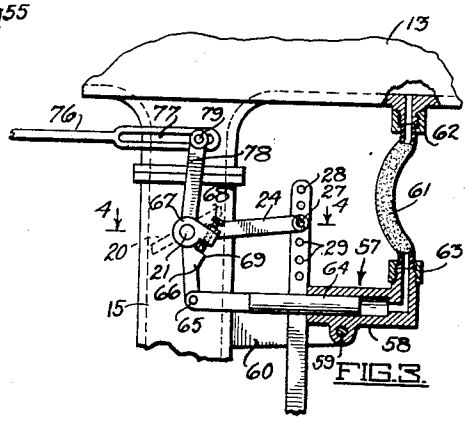


FIG. 3.

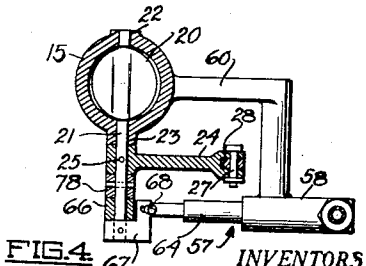


FIG. 4.

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PRIME MOVER REGULATION

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Original application October 22, 1937, Serial No. 170,436. Divided and this application June 17, 1938, Serial No. 214,274

7 Claims. (Cl. 290—40)

This invention relates to regulators for use with motor driven electric generator units and has particular reference to electro-magnetic regulators or governors for automatically regulating the speed and torque of an internal combustion engine, or other prime mover driving a generator, in accordance with the current load on the generator.

As is well known in the art, the voltage output of a constant speed shunt, series or compound generator varies with the current load, except in the case of special compound wound generators. This variation in voltage is very objectionable in many current consuming systems of which illuminating systems having a varying number of lamps in circuit are notable examples.

One object of the present invention is to automatically regulate the output, preferably the voltage, of an electric generator.

A further object is to maintain the voltage output of a generator constant for varying current loads on the generator.

A further object of the invention is to provide a relatively large movement of a controlling element of an electric regulator.

A further object is to utilize the energy of a prime mover to assist in controlling the operation of the same.

A further object of the invention is to reduce the force required to open a butterfly type fuel inlet valve of an internal combustion engine, when the engine is running.

The accomplishment of the above and other objects of the invention will be apparent from the following description read in conjunction with the accompanying drawing wherein:

Fig. 1 is an elevational view of a motor driven generator unit embodying the present invention.

Fig. 2 is a sectional view through the electric regulator.

Fig. 3 is a fragmentary view, partly in section, showing the fuel inlet valve of the engine and its various operating connections.

Fig. 4 is a sectional plan view taken along the line 4—4 of Fig. 3.

This patent application is a division of our copending application Serial No. 170,436, filed October 22, 1937, for "Regulator".

Referring particularly to Fig. 1 the generator unit comprises an internal combustion engine 10, which is shown in the illustration as a gasoline engine having a crankcase 11, a cylinder block 12, a fuel inlet manifold 13, connected in the usual manner to the cylinders (not shown) in the cylinder block 12, a carburetor 14, and a tube or conduit 15, forming part of the manifold 13 and interconnecting the carburetor 14 with the inlet opening of the manifold 13. The crank shaft 16 of the engine 10 is connected to the shaft 17 of a shunt wound generator 18 through a coupling 19.

As shown in Figs. 3 and 4, the fuel inlet valve 20 of the engine is of the butterfly type and is rotatably adjustable within the conduit 15 by a valve shaft 21 journalled in bearings 22 and 23 formed on diametrically opposite sides of the conduit 15. An arm 24, securely mounted at one end thereof as by a pin 25 to the exterior portion of the shaft 21, is pivotally connected at its opposite bifurcated end to a vertically extending link 28 by means of a clevis pin 27. Link 28 has a plurality of spaced bearing holes 29 therein whereby the position of the pivotal connection between the arm 24 and link 28 may be changed. The lower end of the link 28 is pivotally mounted to the extending end of an actuating lever 26 as shown in Fig. 1.

Referring now to both Figs. 1 and 2, the lever 26 is pivotally mounted by means of a clevis pin 30 to the upwardly extending bifurcated portion 31 of an extension 32 formed integrally with a vertically extending core 33 of soft iron, or the like, forming part of the electric regulator to be now described. The core 33 is rigidly secured in relation to the crankcase 11 of the engine 10 through an angle bracket 34. Bracket 34 is secured to the crankcase 11 by bolts 35 and is secured to the lower end of the core 33 by bolts 36. A solenoid 37 is mounted upon a spool consisting of fiber flanges 38 and 39, and a sleeve 40, also of fiber, or like material, such spool being securely mounted in any suitable maner on the lower end of the core 33. A second solenoid 41 is mounted on a similar spool comprising flanges 42 and 43, and a sleeve 44. This second spool, however, is slidable vertically along the core 33 to and from the lower solenoid 37.

The windings of the two solenoids 37 and 41 are connected in series with each other and are wound in opposite directions so that the polarity of the magnetic field produced by one of the solenoids opposes that of the other solenoid. Therefore, on application of current through the two solenoids the upper solenoid 41 will be raised against the force of gravity by an amount depending on the current passing through the solenoids. The solenoids 37 and 41 may, however, be connected in parallel or other circuit relation with each other with their magnetic polarities in opposition to produce the same effect.

A ring shaped flange 45, surrounding the core

33, is secured as by screws 46 to the upper flange 42 of the movable solenoid 41. An upwardly extending lug 47 formed integrally with the flange 46 is pivotally connected to a vertically extending link 48 by a pin 49. The upper end of the link 48 is pivotally secured by means of a pin 50 to a point on the lever 26.

A third coil 51 comprising a small number of turns of heavy conductor wire is wound around the lower solenoid 37 and is secured thereto in any suitable manner, as by being tightly wrapped. This coil 51 is placed in series with the load circuit, generally indicated at 52, of the generator 18 (Fig. 1) and has its polarity opposed to that of solenoid 37. The two solenoid windings 37 and 41, in series with each other, are connected in shunt with the load circuit 52 as diagrammatically shown by the connections 53 and 54.

A rheostat 56 is provided in series with the windings of the solenoids 37 and 41 to allow adjustment required by changes in the resistance of the two solenoids 37 and 41 due to temperature variations therein as well as to vary the voltage level of the generator output circuit.

The load circuit 52 of the generator may be used to supply current to any electrical device. However, in this case it is shown as supplying current to a number of lamps diagrammatically indicated at 55.

The weight of the movable solenoid 41 is such as to move the valve 20, through the force of gravity, toward an open position when the opposing magnetic force between the solenoids 37 and 41 is decreased.

When the butterfly valve 20 is opened from a closed or substantially closed position, an abnormal amount of force is required to move it into an open position due to the excessive vacuum built up within the manifold 13, especially if a high power engine is used. In order to overcome this resistance of the valve a vacuum booster generally indicated at 57 is provided. The booster 57 comprises a cylinder 58 which is pivotally supported by means of a pin 59 on a bracket 60 integrally formed on the conduit 15. A flexible tubing 61 secured at its upper end at 62 to the manifold 13 and its lower end 63 to the cylinder 58 communicates the interior of the manifold 13 with the interior of the cylinder 58. A close fitting plunger 64 is movable within the cylinder 58 and is pivotally secured at 65 to the lower end of an arm 66 journalled on the valve shaft 21. A dog 67 is securely mounted on the extending portion of the valve shaft 21 and has an adjustable screw 68 threadably mounted therein, the end of screw 68 being adapted to abut a boss 69 formed on the arm 66.

When the butterfly 20 is in a closed or substantially closed position, as in a no load condition of the generator, the vacuum produced in the manifold 13 is transmitted through the tubing 61 to the cylinder 58, thereby producing a pull on the plunger 64 tending to open the valve 20. The size of the cylinder 58, however, is such that the vacuum produced in the manifold 13 is insufficient in itself to effect movement of the valve 20, but overcomes the excessive resistance offered to movement of the valve 20 due to the high vacuum in the manifold. It will be noted that the end of plunger 64 is adapted to abut the inlet end of cylinder 58 before the valve 20 is moved to its full open position. Therefore, as plunger 64 reaches the limit of its travel, it becomes ineffective to act upon the valve 20, the remaining movement of valve 20 being accomplished solely through the link 28.

This action of the vacuum booster 57 prevents an undue resistance from being offered to the movement of the solenoid 41, by reason of the vacuum acting against one side of the valve 20, after the engine has been operating with the valve substantially closed, thus insuring a movement of the valve in accordance with the speed changes necessary to obtain constant voltage.

A dashpot 70 is provided to prevent a strain from being imposed on the engine due to a sudden application of current load on the generator and also to prevent a hunting or oscillating movement of the valve 20 on a sudden change of load. Dashpot 70 comprises a cylinder 71 pivotally mounted at 72 to the cylinder block 12 and a double acting piston indicated by the dotted lines 73, movable within the cylinder 71. The piston 73 is attached to an extending portion of lever 26 by means of a piston rod 74 pivotally secured at its lower end to the lever 26 to retard the movement of the solenoid 41 and consequently the butterfly valve 20. Instead of a double acting dashpot for damping any movement of the valve 20 a dashpot acting only on the opening movement of valve 20, may be substituted, permitting the valve to be closed immediately after a load has been removed from the generator, while retarding its opening movement.

A starting control 75 is provided to control the engine 10 during starting. This control comprises a rod 76 manually shiftable lengthwise thereof and having a slot 77 formed at one of its ends. An arm 78 rigidly secured at its lower end to the valve shaft 21 has a pin 79 at its upper end adapted to ride within the slot 77 of the rod 76. When the engine is started the rod 76 is pushed inward, holding valve 20 substantially closed through the engagement of the end of the slot 77 with the pin 79. The rod 76 may be also used to control the operation of the engine independently of the electric regulator in the event that the regulator would become inoperative.

The operation of the regulating apparatus is as follows. Since the solenoids 37 and 41 are connected in series with each other and across the load circuit 52, these solenoids will be responsive to the voltage generated by the generator 18. On operation of the generator 18, the solenoid 41, due to the opposed polarity thereof with the solenoid 37, is raised against the action of gravity an amount determined by the voltage of the current passing therethrough. The rheostat 56 is adjusted to compensate for varying resistance due to temperature changes within these solenoids or to adjust the apparatus for any desired voltage level.

The interaction of the two opposed solenoids 37 and 41 produces a greater amount of bodily movement of solenoid 41 for a given change of current than is possible with the use of a single solenoid only. In view of this feature, wear or looseness in the various pivotal connections of the linkage system between the movable solenoid 41 and the valve 20 has a negligible effect on operation of the engine.

As may be noted in Fig. 1 the solenoid, on raising, moves the lever 26 in a clockwise direction about the pin 30 and therefore, through the link 28 and arm 24, moves the valve toward a closed position to a setting which is predetermined by adjustment of the lengths of the various ele-

ments comprising the linkage between the solenoid 41 and the valve shaft 21.

Preferably this setting is so adjusted that the speed of the engine in a no-load condition of the generator circuit will be approximately the same as when a light current load is applied to the circuit. However, the series coil 51 may be made of such strength, and the linkage between solenoid 41 and valve 20 may be so arranged that the speed of engine 10 may automatically be reduced to idling when the current load is removed from the generator.

On application of a current load on the circuit 52, the field of solenoid 37 will be weakened by the opposing field of coil 51 permitting the solenoid 41 to drop a proportional amount thus opening the valve 20, permitting the engine 10 to develop a higher speed so as to raise the voltage output of the regulator sufficient to compensate for the loss in voltage due to the increased load on the load circuit, bearing in mind that the generator is of the shunt wound type wherein at a constant speed the voltage decreases as the current load increases.

By varying the strength of the series coil 51, the response of the engine 10 may be changed to suit the current-voltage-speed characteristics of the generator. For instance, if the speed of the generator has to be increased only slightly to maintain a constant voltage for a relatively large applied current load, the coil 51 should be weaker than if a greater increase in speed were necessitated for the same current load. The regulator may be over-compensated, if desired, by increasing the strength of coil 51 to compensate for voltage losses in the output circuit line or for other reasons. This change in response may also be obtained by varying the weight of the solenoid 41 or otherwise offering a resistance to the movement thereof.

It will be noted that the present invention obviates the necessity of using springs by employing the force of gravity on the solenoid 41, thus insuring smooth operation without the varying and uncertain action of springs.

While we have described our invention in its preferred embodiment, we desire it to be understood that various modifications may be made therein. For example, although the invention is particularly applicable to generators of the shunt wound type, it is to be understood that it may be used equally well on a series wound or any other type generator as well, using a different linkage or other inter-connecting means between the electrical regulator and the valve 20 so as to operate the valve 20 in accordance with the current-voltage curve of the particular generator employed. For example, instead of a straight line link connection as shown, any suitable non-linear cam or like interconnection between the regulator and the fuel valve may be employed. Furthermore, for small power engines which do not require an excessive force to open the butterfly valve, the vacuum booster may be omitted.

We claim:

1. In a controlling device, an electric generator, a prime mover operatively connected to said generator, means for controlling the operation of said prime mover, a pair of electro-magnetic coils adapted to react on each other and connected in shunt with the load circuit of said generator, means whereby said coils are adapted to move relatively to each other through the electro-magnetic action of the current passing through said coils, means operatively connecting said first mentioned means and one of said coils to transmit bodily movement to said first mentioned means and means responsive to the current flow in said load circuit for modifying the electro-magnetic effect of one of said coils.

2. A controlling device in accordance with claim 1 wherein said last mentioned means comprises a third electro-magnetic coil in series with said load circuit.

3. In a controlling device, an electric generator, a prime mover operatively connected to said generator, means for controlling the operation of said prime mover, a pair of electro-magnetic coils electrically connected with each other and opposing each other, said pair being connected in shunt with the load circuit of said generator, means for supporting one of said coils in a fixed position, means whereby the other of said coils is adapted to be moved relative to said fixed coil against the force of gravity through the magnetic action of the current passing through said coils, means responsive to the movement of said movable coil for operating said first mentioned means and a third coil in series with said load circuit and adapted to oppose one of said first mentioned coils.

4. A device for automatically controlling the operation of a motor in accordance with the current load on a generator driven by said motor comprising means for controlling the operation of said motor, a fixed electro-magnetic coil having an upwardly extending core, an operative connection between said controlling means and said movable coil, a second electro-magnetic coil movable along said core, said coils being electrically connected with each other and in shunt with the load circuit of said generator, with their magnetic fields in opposite directions and adapted to react upon each other against the force of gravity in accordance with the voltage of said load circuit, and a third coil connected in series with said load circuit, said third coil having its magnetic field in an opposite direction to the field of said fixed coil whereby to modify the field of said fixed coil in accordance with the current in said circuit.

5. In a motor driven generator apparatus, the combination of a prime mover, means for controlling the operation of said prime mover, an electric generator operatively connected to said prime mover, a regulator responsive to said generator for operating said first mentioned means, and means actuated by said prime mover for assisting said regulator when starting said prime mover.

6. In a motor driven generator apparatus, the combination of an internal combustion engine having a fuel inlet valve, a generator operatively connected to said engine, a regulator responsive to the voltage of said generator for operating said valve, and means responsive to the difference in air pressure on opposite sides of said valve for controlling said regulator.

7. In a motor driven generator, the combination of an internal combustion engine having a fuel inlet valve, a generator operatively connected to said engine, means responsive to the current in the load circuit of said generator for operating said valve, and a vacuum booster adapted to urge said valve toward an open position when in a substantially closed position, said booster being substantially ineffective at a substantially open position of said valve.

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