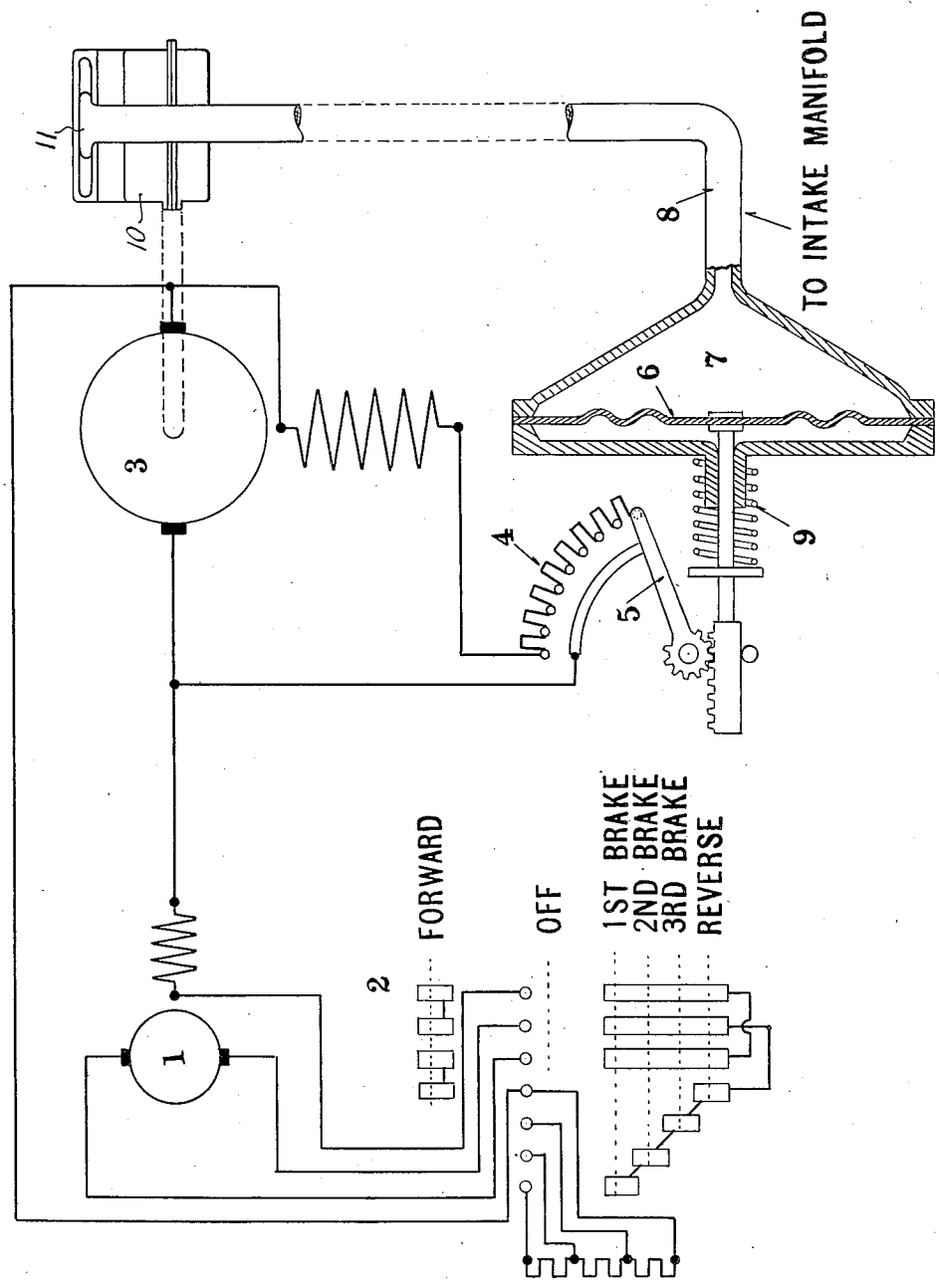
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GAS ELECTRIC POWER APPARATUS

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INVENTOR

Otis E. Turner

BY E. E. Huffman

ATTORNEY

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# UNITED STATES PATENT OFFICE

OTIS E. TURNER, OF KIRKWOOD, MISSOURI, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

## GAS ELECTRIC POWER APPARATUS

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My invention relates to vehicle power equipment of the type comprising an internal combustion engine, a generator driven thereby, and a vehicle driving motor supplied with current by the generator. The object of the invention is to provide means whereby the engine when starting the vehicle and while propelling it at the lower speeds imposed, for example, by an ascending grade, may operate at a speed approximating its most efficient speed. I achieve this object by automatic regulation of the electrical equipment in response to pressure variations occurring in the intake or exhaust manifolds of the engine under different conditions of speed and throttle opening.

The accompanying drawing, which, is chiefly diagrammatic, illustrates the electrical elements and circuits of an apparatus embodying my invention and shows, in section, a suitable form of device for actuating the regulator in accordance with variations in pressure in the intake manifold of the engine.

The series motor 1, connected to a driving shaft or wheel of the vehicle, and whose circuits are controlled by controller 2, is supplied with current by the shunt generator 3 which is directly connected to and driven by an internal combustion engine 10, said engine constituting the primary source of power. A rheostat 4 is included in the field circuit of the generator. The switch arm 5 of the rheostat is actuated in any suitable manner by the pressure-operated flexible diaphragm 6, a rack and pinion connection being shown. This diaphragm forms a wall of the chamber 7 which communicates, by means of pipe 8, with the intake manifold 11 of the engine. The position of the diaphragm when the pressure in the chamber 7 is atmospheric is shown in the drawing, spring 9 being provided to positively bring it to this position and to move the rheostat controller-arm to the position shown in which full resistance is included in the field circuit of the generator.

As is well known, an internal combustion engine is most efficient when operating at a particular speed, meaning by "efficiency" the relation of fuel consumed to power produced; also the maximum horse power which an automobile engine of usual design and of a given size, can develop, is secured at a speed at least not lower than the most efficient operating speed just referred to.

Since the torque demand for operating a large vehicle, such as a bus or rail car upon which "gas-electric" systems are used, is higher when starting the vehicle or operating it on an ascending grade than when in normal operation on the level, a gain in efficiency, and power for a given size, can be secured by providing means whereby the engine may operate at a relatively high speed, and in the vicinity of its most efficient speed, while the vehicle is being started, or is moving at a low speed up a grade.

In the embodiment of my invention herein described a close approach to the desired constant engine speed for varying vehicle speeds referred to, is secured by utilizing variation in pressure in the intake manifold of the engine to vary the resistance in the field circuit of the generator. Assuming that the engine has been started and is running idle, the motor controller being in off position, and the motor and generator circuits therefore open,—the first step in starting the vehicle is to place the motor controller in forward position thereby connecting the motor to the generator. The engine throttle is then opened and the pressure in the intake manifold is temporarily increased, whereupon the diaphragm 6 moves to the position where the resistance 4 is included in the generator field circuit. Full throttle results in an increase in engine speed, whereupon the pressure on the diaphragm 6 is again reduced below atmospheric pressure to a sufficient extent to cause the diaphragm 6 to be drawn to the right and the controller-arm of the rheostat to be moved to reduce the resistance in the generator field circuit. The size of the diaphragm 6 is preferably so chosen for a particular engine, and with relation to the power required to move the rheostat arm against the resistance of friction and of the spring 9, that at speeds of the engine corresponding to and above its most efficient speed the controller-arm will be held in such position as to exclude all of the resistance of the rheo-

stat from the field circuit of the generator. If an attempt is made to accelerate the vehicle by opening the throttle, or an upgrade is encountered and the throttle is opened, the diaphragm 6 again moves to the position where the resistance 4 is included in the generator field circuit, thereby weakening the field and thus lowering the generator voltage for a given speed. Under these conditions, the speed at which the generator must run to produce a given output increases, and therefore the engine is permitted to deliver the required power at a higher speed than it would attain with the same power consumption at the wheels of the vehicle if no resistance were included in the generator field circuit. When the vehicle attains the desired speed and the torque demand has become less than during acceleration, the engine speed and the vehicle speed would tend to increase but this is prevented by reducing the engine throttle opening. Since at normal vehicle operating speeds the engine speed and throttle opening are such that the pressure in the intake manifold causes the diaphragm 6 to be held in the position in which all of the resistance is cut out of the field circuit, the generator voltage at such speeds will have the value in relation to output for which it was designed.

It will be understood that instead of connecting the pressure device controlling the rheostat to the intake manifold of the engine it may be connected to the exhaust manifold, suitable change being made in the mechanism illustrated whereby increasing pressure rather than decreasing pressure results in decreasing the amount of resistance in the field circuit of the generator.

In its broader aspect my invention consists in the utilization of varying conditions of engine operation to vary the operation of the electrical power elements for the purposes referred to, and I do not intend that the scope of my invention be limited further than set-forth in the claims.

Having fully described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. The combination with a device to be driven, of an internal combustion engine, electrical means for transmitting the power of the engine to the driven device, a voltage regulator for the electrical means, and means controlled by a variable fluid pressure for actuating the regulator, said last mentioned means being responsive to variations in speed of said engine.

2. The combination with a device to be driven, of an internal combustion engine, electrical means for transmitting the power of the engine to the driven device, a regulator for the electrical means, and means for deriving a variable fluid pressure from the engine for actuating the regulator.

3. The combination with a power apparatus comprising an electric motor, a generator for supplying current thereto and an internal combustion engine for driving the generator, of a fluid pressure actuated device for regulating the generator, and means for deriving a variable fluid pressure from the engine for actuating said regulator.

4. The combination with a power apparatus comprising an electric motor, a generator for supplying current thereto and an internal combustion engine for driving the generator, of means controlled by variation in pressure in a fuel intake passage of the engine for regulating the generator.

In testimony whereof, I hereunto affix my signature this 22nd day of March, 1926.

OTIS E. TURNER.