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CONTROL FOR ENGINE GENERATOR UNITS

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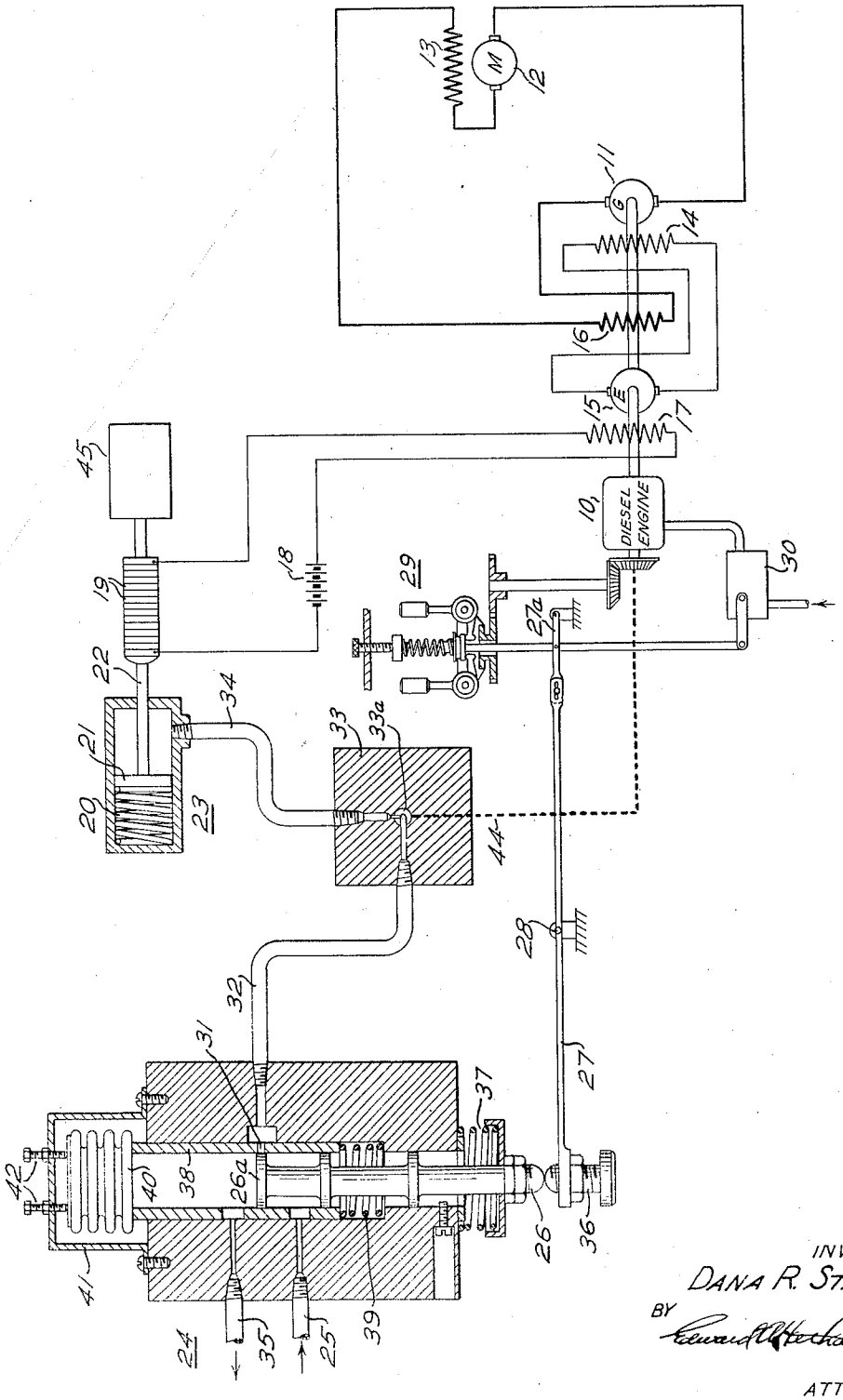

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CONTROL FOR ENGINE GENERATOR UNITS

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This invention relates generally to internal combustion engine generator equipment and has for an object the provision of improved means for regulating the generator output so as to prevent overload of the engine during operation at high altitudes.

As explained in Stamm Patent 2,311,285, it is desirable to regulate the generator output so that the engine will operate under maximum constant horsepower output, without the possibility of being stalled on account of overload. This is of particular importance in locomotives, where the engineman may at different times operate the throttle to call for a maximum output from the Diesel engine. In accordance with said Stamm patent, the energization of an exciter winding is varied in response to the speed of the Diesel engine so as to prevent overload of the engine. Though this system has been found very effective for most applications, it does not correct for overloads imposed due to a decrease in the load capacity of the Diesel engine, such, for example, as results from operation at high altitudes.

In accordance with the present invention, it has been found that internal combustion engines, including the Diesel, develop a materially lower horsepower output as the atmospheric pressure decreases. In locomotives operating on transcontinental service, this effect has been very great where the train passes over the mountainous regions. Because of the limitation on output with atmospheric pressure, it is important to prevent overloading of the engine while it is operating in mountainous regions where it is to be expected that the maximum safe load will be needed over substantial periods of time.

Accordingly, it is a further object of the present invention to provide improved means for automatically regulating the load in response to change in atmospheric pressure to avoid overloading the engine.

In carrying out the invention in one form thereof, there is provided means responsive to atmospheric pressure to modify the operation of a load-determining means to limit the power imposed on the engine by the generator. In the preferred form of the invention, this is accomplished by adjusting the valve element in a hydraulic control system to establish operation over a lower range of loads for the engine.

For a more detailed understanding of the invention, and for further objects and advantages thereof, reference is to be had to the following description taken in conjunction with the accompanying drawing in which there has been diagrammatically illustrated a system embodying the invention.

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Referring to the drawing, the invention in one form has been shown as applied to the control of the load imposed on a Diesel engine **10** by a generator **11** connected to supply one or more traction motors, one of which, the motor **12**, has been illustrated, together with its series field winding **13**. The field winding **14** of the generator is energized by means of an exciter **15** having a winding **16** connected in series-circuit relation with the generator **11** and motor **12**. The exciter **15** is also provided with a winding **17** energized by any suitable direct current source of supply, such as a battery **18** under the control of a resistor **19** of the carbon pile type. Normally, a compression spring **20** applies a pressure to the piston **21** which is transmitted by the piston rod **22** to the carbon pile resistor **19**. As is well understood in the art, the resistance of the carbon pile resistor **19** varies from a maximum value, in the absence of pressure, to a minimum value with maximum pressure applied thereto.

As fully explained in said Stamm Patent 2,311,285, the hydraulic actuator **23**, which includes the piston **21**, is controlled by a regulator **24** supplied with liquid pressure through a pipe **25** from any suitable constant pressure source. The regulator **24** includes a valve operating rod **26**, operatively connected to a lever **27** pivoted at **28** and operable by a lever **27***a* under the control of a governor **29** of the Diesel engine **10**. The arrangement, well known to those skilled in the art, and diagrammatically illustrated, utilizes the characteristics of the governor **29**, which is of the isochronous type, to control by suitable means **30** the injection of fuel to the engine **10**. In other words, fuel is supplied to the engine **10** in amount for development of its normal output at the normal speed thereof. Should the load imposed by the generator **11** rise, as when the train starts up a grade, there will be a momentary decrease in the speed of the engine **10** and of the governor **29**. Additional fuel will be supplied to the engine by the means or device **30** and the lever **27***a* will rotate the lever **27** in a clockwise direction to lift the valve operating rod **30** against the bias of a spring **37**. The valve element **26***a* will uncover the port **31** to admit fluid from the pipe **25** to a pipe **32**, and to flow-restricting means **33**, and by pipe **34** to the actuator **23**. Accordingly, the increased fluid pressure will move the piston **21** to the left, as viewed in the drawing, to reduce the pressure on the carbon pile resistor **19**. This reduces the field strength on the exciter and the resultant de-

crease in the excitation of the generator 11 decreases the load imposed by it upon the Diesel engine 10 to allow the engine speed substantially to return to its normal or predetermined speed. An adjusting means, such as a threaded stud 36, is provided to predetermine the position of the valve operating rod 26. Its normal position is shown in the drawing, with the valve element 26a in alignment with and closing the port 31. A decrease in the load imposed upon the engine 10 produces the reverse operation; that is, the governor 29 responds to a momentary increase in the engine speed and the rod 26 is moved downwardly by the bias of the spring 37 to connect the port 31 to an outlet pipe 35 to reduce the pressure in the actuator 23. The spring 20 thereupon increases the pressure on the carbon pile resistor 19 to increase the excitation, and the load, of the generator 11.

For both conditions, of increasing and decreasing load on the Diesel engine 10, it is to be understood the pressure changes will be of an incremental nature; that is, a slight change from the normal full load on the Diesel engine 10 will, through action of the governor 29, adjust the fuel supply thereto and the load imposed thereon by the generator 11. If its normal full load is not then attained, further controlling actions will occur until the normal full load and the predetermined speed of the engine have been attained.

In accordance with the present invention, the relative position between the rod 26 and the opening or port 31 of the valve element 26a is varied in accordance with atmospheric pressure. This is accomplished by providing a sleeve 38 in which the outlet opening or port 31 is located. The sleeve 38 is biased by a spring 39 against an expansible bellows 40 mounted within a housing 41. The initial compression of the bellows 40 may be varied by adjustable stops 42. Accordingly, as the barometric pressure decreases, the bellows 40 will expand and move the sleeve 38 against the bias of the spring 39, to establish a normal load for the engine 10 lower than its previous value. This is accomplished by an immediate reduction in the pressure applied to the actuator 23 for the predetermined or normal speed of operation of the Diesel engine 10. Accordingly, the excitation of the generator 11 will be decreased, thereby limiting the load imposed by the generator 11 on the Diesel engine. If the locomotive be climbing a mountain, the foregoing adjustments will take place automatically and there will be avoided any danger of overloading the Diesel engine; and, more importantly, there will be avoided any possibility of stalling it. It is again emphasized that the maximum output of a Diesel engine is materially less at high altitude, such, for example, as 6000 feet, than it is at sea level. It may be as much as twenty-five per cent less than it would be at sea level. The importance of the automatic control provided by the present invention to prevent stalling of the engine, particularly on heavy mountain grades where subsequent starting of the train may be difficult, will now be thoroughly appreciated.

The bellows 40 may be sealed at sea level and suitable adjustments made by means of the adjustable stops 42. It is to be understood the invention is not limited to an expansible bellows sealed at sea level. Obviously, it may be replaced by any mechanism operable in response to atmospheric pressure variably to position the sleeve 38 in accordance with changes therein. Similarly, other fluid pressure regulating means may be utilized, and the flow-resistance means 33 may, under some circumstances, be replaced by an orifice. However, the flow-resistance means 33 has proved to be more satisfactory than an orifice or a capillary tube. Briefly, it consists of a cylindrical member 33a rotated by the Diesel engine as indicated by the broken line 44. The member 33a has an opening or flow channel therein which is in continuous communication with the pipe 32. It is moved periodically to a position to communicate with the pipe 34; that is, once every revolution. The effect is the same as though a capillary tube interconnected the pipes 32 and 34 to provide a slow change in pressure in the actuator 23 with changes in speed of the engine 10. The flow-resistance means 33 eliminates "hunting" and acts to damp out the effect on the actuator 23 of momentary changes in the speed of engine 10.

The variable resistor 19 may also be used for starting the locomotive by means of an actuator 45 which may be of any suitable type. It applies to the carbon pile resistor 19 a gradually increasing pressure to apply a rising excitation to the generator 11. It may then be retained in a fixed position for normal operation. Thus, the actuator 23 may function in conjunction with the actuator 45 or independently of it, in either case serving adequately and effectively to limit and to regulate the load on the engine 10.

While the preferred form of the invention has been illustrated, it is understood that modifications may be made within the spirit and scope of the appended claims.

What is claimed is:

1. In an internal combustion engine generator having a field, the combination of means responsive to the engine speed for controlling the strength of said field for predetermining the maximum load which may be imposed upon the engine to prevent overloading thereof, and means operable by changes in atmospheric pressure for adjusting said control means so as to additionally control the strength of said field for reducing the value of said maximum load imposed on said engine with decreasing atmospheric pressure.

2. In an internal combustion engine generator equipment, the combination of means for predetermining the maximum load which may be imposed by said generator upon said engine, and means responsive to changes in atmospheric pressure for reducing the value of said maximum load with lowering of said atmospheric pressure.

3. In an internal combustion engine generator equipment, the combination of a control member positioned in accordance with the speed of said engine, load-controlling means for said generator, an actuator operable by fluid pressure applied thereto and operatively associated with said load-controlling means, a regulating valve flow-connected to said actuator to vary the fluid pressure applied thereto, said valve having one element thereof positioned by said control member to limit the load imposed by said generator upon said engine, said valve having a second cooperating element for modifying the setting of said one element, and means operable in accordance with atmospheric pressure for positioning said second element to reduce the permissible load on said engine as the atmospheric pressure decreases.

4. In a locomotive having an internal combustion engine driving a generator which supplies the traction motors thereof, the combination of a control member positioned in accordance with the

speed of said engine, load-controlling means for said generator actuated by fluid pressure, a fluid-pressure regulating valve having two relatively movable elements for regulating the magnitude of said fluid pressure, one of said elements being positioned by said control member, and means operable in accordance with change in the atmospheric pressure for positioning the other of said elements.

5. In a locomotive having an internal combustion engine driving a generator which supplies the traction motors thereof, the combination of a control member positioned in accordance with the speed of said engine, load-controlling means for said generator actuated by fluid pressure, a fluid-pressure regulating valve having two relatively movable elements for regulating the magnitude of said fluid pressure, low-resistance means between said valve and said actuator for reducing the rate of change of pressure on said load-controlling means, one of said elements being positioned by said control member, and means operable in accordance with change in the atmospheric pressure for positioning the other of said elements to reduce the load imposed by said generator on said engine as said atmospheric pressure decreases.

6. In an internal combustion engine generator equipment, the combination of a control member positioned in accordance with the speed of said engine, load-controlling means for said generator, an actuator operable by fluid pressure applied thereto and operatively associated with said load-controlling means, a regulating valve flow-connected to said actuator to vary the fluid pressure applied thereto, said valve having one element thereof positioned by said control member to limit the load imposed by said generator upon said engine, said valve having a second cooperating element for modifying the setting of said one element, anti-hunting means interposed in the flow connection between said valve and said actuator comprising a rotating flow channel which periodically connects said valve to said actuator to regulate the extent of change of pressure thereon with changes in the setting of said valve, and means operable in accordance with atmospheric pressure for positioning said second element to reduce the permissible load on said engine as the atmospheric pressure decreases.

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