Oct. 1, 1929. G. F. SMITH 1,730,340

POWER GENERATING SYSTEM

Filed July 6, 1926 2 Sheets-Sheet 1

Fig. 1.

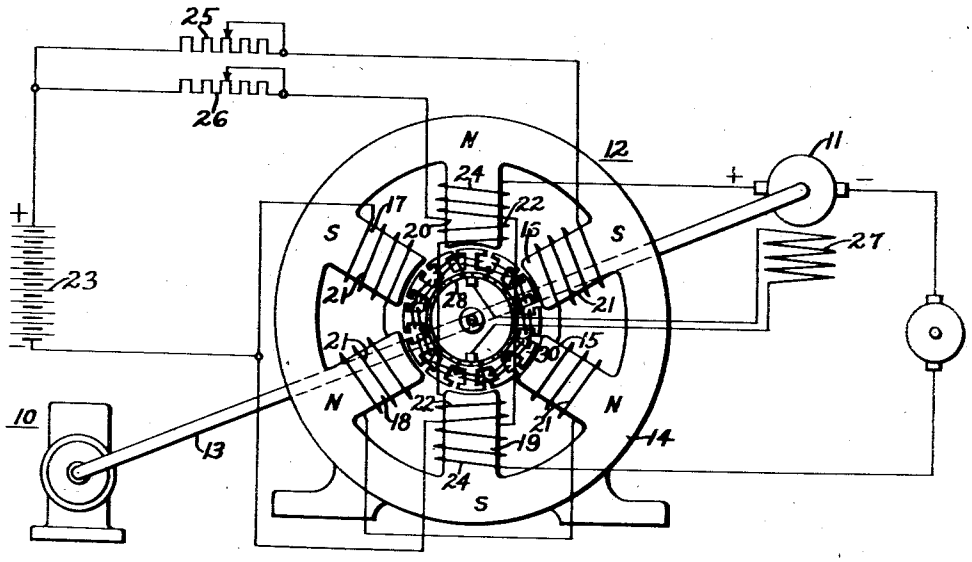
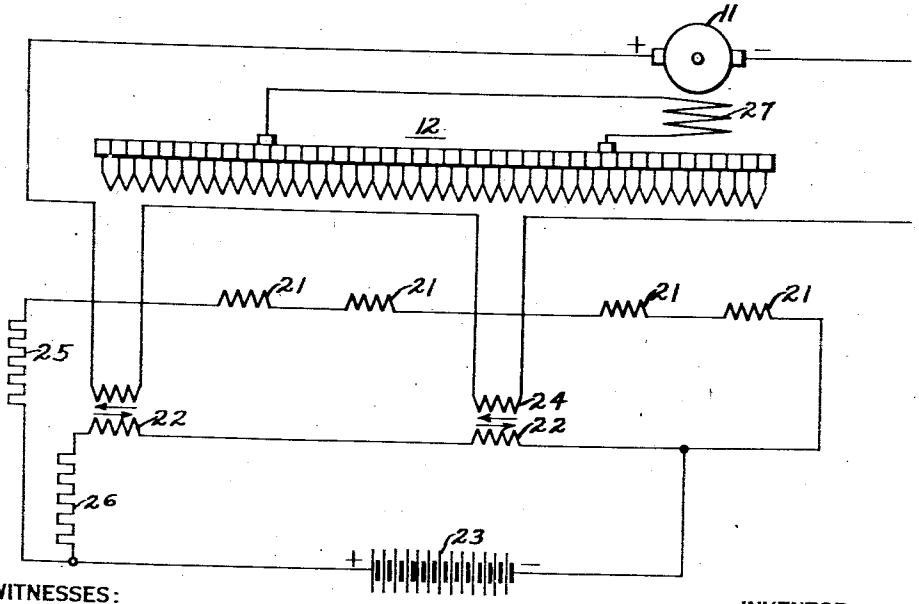


Fig. 2.



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Fig. 3.

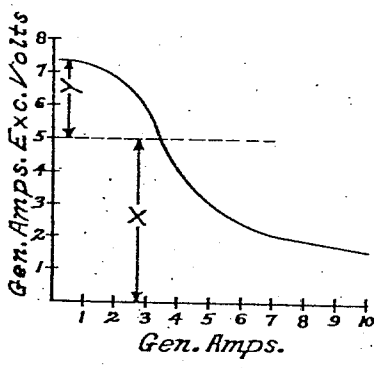


Fig. 4.

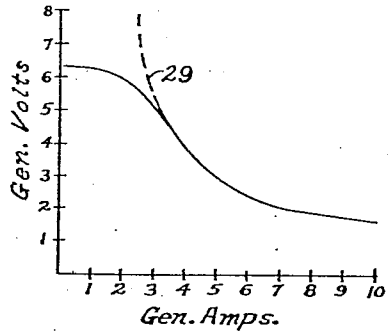
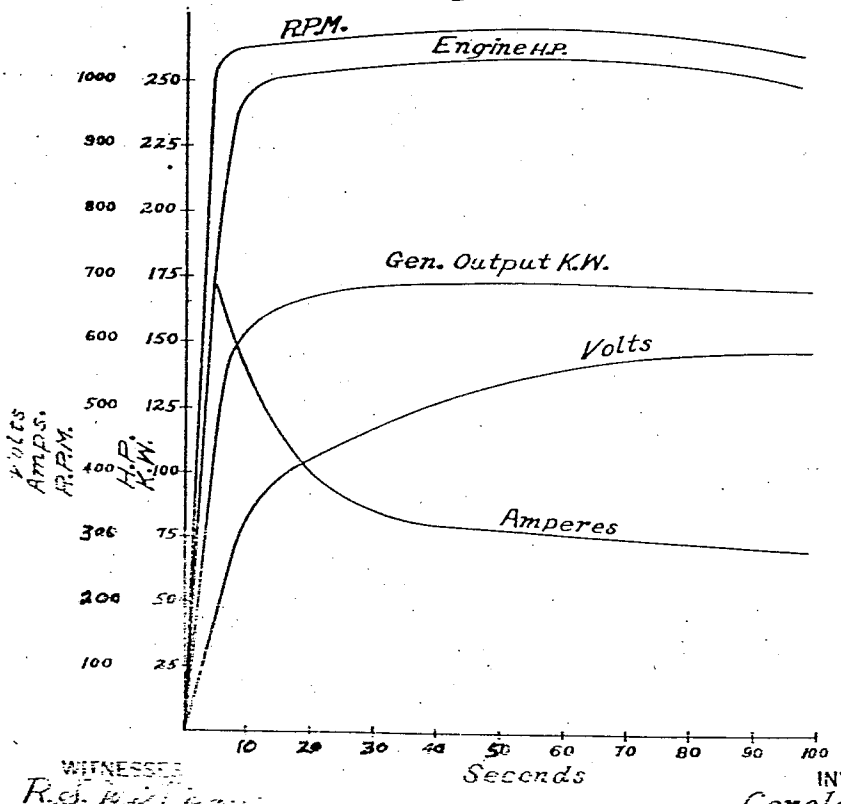


Fig. 5.



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UNITED STATES PATENT OFFICE

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POWER-GENERATING SYSTEM

Application filed July 6, 1926. Serial No. 120,566.

This invention relates generally to gas-electric power systems or transmissions and more particularly to power systems in which Diesel engines are used as prime movers.

In the operation of gas or oil engines it is found that they are limited in capacity and that they do not function satisfactorily when subjected to loads in excess of their rated horse-powers. Accordingly, it is desirable to use them in power systems in which the auxiliaries take care of the fluctuations in load, thus allowing the gas or oil engines that are utilized as prime movers to be operated at substantially rated horse powers over wide ranges of load.

The object of the invention, generally stated, is the provision of a gas-electric power system that shall be simple and efficient in operation and readily and economically manufactured and installed.

A more specific object of the invention is to provide for the utilization of the full horse-power of a gas or oil engine over a wide range of load.

Another object of the invention is to provide for the variation of the voltage of a gas-electric power system inversely as the load in order to obtain the desired operating characteristics.

Other objects of the invention will, in part, be obvious and will, in part, appear hereinafter.

The invention accordingly is disclosed in the embodiment thereof shown in the accompanying drawing, and comprises the structural features, the combination of elements and the arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing in which;

Fig. 1 is a diagrammatic view of a power system showing, generally, the structure of an exciter constructed in accordance with this invention;

Fig. 2 is a diagram of connections used in the power system;

Figs. 3 and 4 are curves showing the operating characteristics of a power system constructed in accordance with this invention; and

Fig. 5 is a copy of a curve sheet prepared from an actual test of a car equipped with a power system constructed in accordance with this invention.

Referring now to the drawing, the power system illustrated comprises an internal-combustion engine designated, generally, by the reference character 10, which is directly connected to the generator 11 and exciter 12. The engine, generator and exciter may be connected in any suitable manner and, in this particular embodiment of the invention, in order to simplify the drawing, they are shown as provided with a common shaft 13.

As illustrated, the exciter 12 comprises a frame 14 carrying a plurality of inwardly extending cores or polar projections 15 to 20, inclusive. In this particular construction, only six polar projections are provided, but it is pointed out that different numbers may be used in order to meet different operating conditions. It will be readily understood that the drawing is only a diagrammatic showing and that the polar projections or cores may be constructed in any suitable manner, well-known in the art and from some material such as an iron having the desired magnetic properties and prepared in the form of laminated sheets.

Four of the cores, 15 to 18, inclusive, are provided with separately excited windings 21. As shown, these windings are connected across a battery 23. The other two cores, 19 and 20, are also provided with separately excited windings 22. The windings 22 may be excited from any suitable source and, in this particular case, they also are connected across the battery 23.

In addition to the windings 22, the cores 19 and 20 have differential windings 24 mounted thereon which are connected in series with the armature of the generator 11. The number of turns in the windings 22 and 24 that are provided on the cores 19 and 20

will depend on the operating conditions it is desired to meet.

In designing the exciter, the cores 19 and 20 or the armature teeth 30 may be made of any desired cross-sectional area so that they will become saturated upon the flow of a predetermined current in either of the windings 22 and 24. The energization of the cores 15 to 20, inclusive, may be controlled by the insertion of variable resistors 25 and 26 in series relation with the coils 21 and 22, respectively. While, in this particular construction, the cores 19 and 20 are made of the desired cross-sectional area to assure saturation upon the flow of a predetermined current in the coils 22 or in the coils 24, other methods may be adopted for effecting saturation of the cores upon the flow of a predetermined current in these coils.

The field winding 27 of the generator is connected across the armature 28 of the exciter 12. Consequently, the generator will be excited in accordance with the voltage developed by the exciter 12.

During the operation of the exciter, when the generator 11 is loaded, the current in the coils 24 gradually increases until it neutralizes the effect of the current delivered by the battery 23 and finally reverses the polarity of the polar projections 19 and 20. This causes the lines of magnetic forces to flow in the opposite direction in the frame 14.

In order to permit such reversal of the magnetism without interference between the respective magnetic circuits, which might prevent the obtaining of the desired operating characteristics from the exciter, the frame and armature core section under the armature teeth 30 are made of greater cross-sectional area than required for an ordinary separately-excited machine in which no reversal of the magnetic field is effected. This increase in size of the frame may be provided for without excessive expense or undesirable increase in weight on account of the small size of the exciter relative to the other machines in the power system.

When the power system is in operation without a load on the generator 11, no current flows in the coils 24 on the cores 19 and 20. Consequently, the cores are magnetized by the coils 21 and 22, which are connected across the battery or constant-voltage source of current 23. This separate excitation of the coils 21 and 22 gives the cores 15 to 20, inclusive, progressing in either direction about the frame, a polarity of north and south, alternately. In view of the fact that the cores 19 and 20 are made of a predetermined cross-sectional area, they become saturated upon the flow of a predetermined current in the coils 22.

The voltage developed at the terminals of the exciter is the result of the cumulative effect of the windings 21 and 22. For purposes of explanation, reference is made to the curve shown in Fig. 3, which shows the effect of the windings 21 on the cores 15 to 18, inclusive, in building up a voltage at the exciter terminals of the value X, while the coils 22 on the cores 19 and 20, when the generator is not loaded, add a voltage equal to the value Y. Consequently, the total voltage of the exciter unloaded is X+Y.

Assume now that the generator is gradually loaded and that the current in the coils 24 is gradually increased. Under such operating conditions, the magnetizing effect of the current in the coils 22 is continuously cut down until it is completely neutralized, and the voltage at the terminals of the exciter is equal to X, or is the voltage that results from the excitation of the coils 21. As the current in the coils 24 increases above that required to neutralize the coils 22, the voltage of the exciter decreases in accordance with the curve shown in Fig. 3. However, in view of the arrangement of the coils, the curve tends toward a horizontal line and more nearly conforms to the shape of the constant horse-power curve, such as the dotted curve 29 shown in Fig. 4, which coincides with the lower portion of the exciter-voltage curve illustrated in Fig. 3.

In order that the operating characteristics of this power system may be more readily appreciated, the curves shown in Fig. 5, which were plotted from a test made on a power system constructed in accordance with this invention and installed on a gasoline-electric car, have been embodied in the drawings. The gas-electric car on which the test was made weighed 95,020 pounds and was equipped with a Diesel engine of 250 horsepower, a single generator and two parallel-connected motors. A study of the curves will show that the engine horse-power curve was maintained substantially constant at approximately the rated horse power.

Accordingly, a simple and effective power system in which the engine horsepower remains substantially constant over a wide range of load is provided.

Since certain changes may be made in the above construction, and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

I cliam as my invention:

1. In a power system, in combination, a generator, an exciter for the generator, said exciter being provided with separately excited field windings having a plurality of cores, and differential field windings disposed on selected cores less than the total number, and a constant-voltage-current source for energizing the separately excited field windings, said differential windings being

connected to carry the generator current, thereby to vary the energization of said selected cores inversely as the load on the generator.

2. In a power system, in combination, a generator, an exciter for the generator, said exciter being provided with separately excited field windings provided with a number of poles and a differential field winding having a smaller number of poles, an independent constant-voltage current source for energizing the separately excited field windings, said generator being connected to the differential field windings to oppose the energization of the separately excited field windings, thereby to vary the voltage of the exciter inversely as the load on the generator.

3. In a power system in combination, a generator, an exciter for the generator, said exciter being provided with a frame having a plurality of polar projections, field windings provided on each of the polar projections, a constant voltage source for energizing said field windings, differential field windings provided on a number of the polar projections less than the total number, said differential field windings being connected to carry the generator current and to oppose the field windings to vary the exciter voltage inversely with the generator current to maintain a substantially constant horsepower output from the generator.

4. In a power system in combination, a generator, an exciter for the generator, said exciter being provided with field windings having a plurality of polar projections, a constant voltage source for energizing said polar projections and differential field windings provided on two of the polar projections and connected to carry the generator current, the polar projections provided with differential field windings being made of such cross-sectional area that they are saturated with lines of flux when the field windings are connected across a constant voltage source, and when the generator current reaches a predetermined value substantially equal to full load current.

In testimony whereof, I have hereunto subscribed my name this first day of July, 1926.

GERALD F. SMITH.