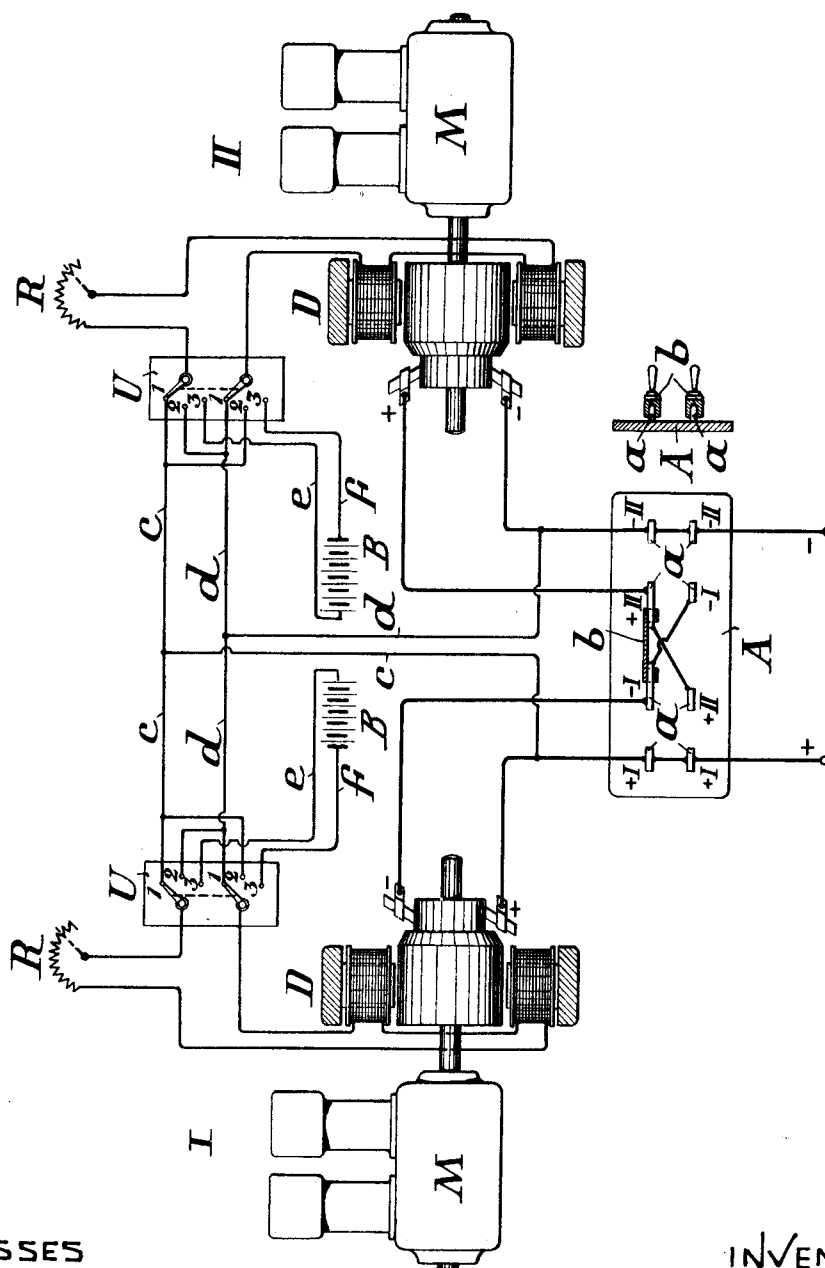


W. A. T. MÜLLER.
 SYSTEM AND METHOD OF PRODUCING, BY MEANS OF COMBUSTION ENGINES, ELECTRIC CURRENT.
 APPLICATION FILED MAR. 29, 1909.

1,064,981.

Patented June 17, 1913.



WITNESSES

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SYSTEM AND METHOD OF PRODUCING, BY MEANS OF COMBUSTION-ENGINES, ELECTRIC CURRENT.

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Specification of Letters Patent.

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Application filed March 29, 1909. Serial No. 486,407.

To all whom it may concern:

Be it known that I, WILHELM ADOLF THEODOR MÜLLER, engineer, a subject of the German Emperor, residing at 5 Feldstrasse, Berlin-Steglitz, Germany, have invented certain new and useful Improvements in Systems and Methods of Producing, by Means of Combustion-Engines, Electric Current; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in a system and a method of producing, by means of combustion engines, electric current the strength and the voltage of which are very variable.

The improved method is particularly adapted for use in the traveling dynamo system of electrically driven railless freight car trains, in which the speed is regulated by changing the voltage of the system. In order to decrease the losses in case of small loads, systems of this character are composed of a plurality of independent sets of machine, such for example as benzine dynamos, (that is dynamos which are directly coupled with benzine engines). Of these sets of machines only such a number is in operation as is required to supply the necessary energy, the resistance of which energy is dependent on the number of the freight cars and the resistance of the road.

The main object of the invention is to provide a system, whereby the said independent sets of generators included in the same circuit are more readily controlled, so that one man can start and govern all the generators.

A further object of the improvements is to provide a system in which the apparatus required for controlling the system are simple, while the operation of the train is safe.

With these objects in view, the invention consists in regulating the amount of the energy supplied by each set, and its direction of operation by varying the intensity of the exciting current of the dynamos the armatures of which are connected in series, all as hereinafter described.

For the application of my invention it is a prerequisite, that the dynamos be provided with appropriate well known means, such as commutator poles or compensating coils, to

permit the regulation of the magnetic fields without regard to the armature fields. Furthermore, the method can not be applied, before an electromotive force is produced in the system. Therefore, when starting the system, the first set of machines must be started by hand or in another suitable manner. However, the initial electromotive force required in the system can also be supplied by a storage battery.

In the accompanying drawing illustrating the invention applied by way of example to two cooperating benzine dynamos, I and II represent the two sets of machines, M the benzine engines, and D the dynamos.

A is a switch-board provided with projecting contacts *a* which are connected with the armature leads (shown in thick lines) and can be interconnected in various ways by means of contact pieces *b*. In the position shown in the drawing, in which the contact piece *b* connects -I with +II, the two armature circuits are connected in series.

Preferably, the armatures of the various sets of machines are connected in series from the beginning of the operation, and in this case means are preferably provided whereby the armature of each set can be short-circuited, in order to avoid losses of energy and heating of the armatures which are out of operation. While the amount of energy required is small, for example if only the car of the train which carries the system is run, or if it is coupled to a single car, only one set of machines is in operation. To produce this result, one of the sets of the machines, for instance, II, can be disconnected by placing another contact piece *b* in the position (+II, -II) and when it is desired to considerably increase the supply of current, the two dynamos are connected in parallel by using two contact pieces *b* in the positions (+I, +II) and (-I, -II). If, however, several cars are to be coupled to the motor car in the course of its travel, or if a train of the usual length, such for example as a train of six cars, must travel over steep roads, so that the amount of energy required varies from a minimum (occurring on downgrades) to a maximum, the short-circuiting of the armatures is removed, whereupon the improved method can be employed.

As soon as the first set of machines is insufficient to produce the amount of energy required, the second one is thrown into op-

eration. At the beginning, the latter counteracts the effect of the first set, because it must be started, for which purpose its field excitation is so directed, that the dynamo produces a momentum for starting the benzine engine. The leads shown in thin lines represent the field exciting circuit in which a two-pole switch U and a variable shunt resistance R are provided for each dynamo. Each of the said switches U can be moved on to three contacts referred to on the drawings as 1, 2 and 3 respectively. The contacts 1 and 2 are connected by means of the leads c and d to the + and - poles in the manner indicated, so that when the contact lever of the switch U is on either of the contacts 1 and 2, the dynamo D receives its exciting current from one of the working machines, said current flowing in the one direction, when the contact lever is on the contact 1, and in the other direction, when the contact lever is on the contact 2. As soon as the engine being started is in operation, the direction of the field excitation is reversed, whereupon the second set supplies positive energy to the circuit. The same operation takes place in further sets of machines, if such are provided. The field exciting current for the machine to be started can be taken from the set or sets which are already in operation, or from a storage battery. When the contact lever is moved on to the contact 3, the exciting circuit is connected by the leads e and f with a source of current (such as that shown at B) in order to start the excitation and thereby the operation of the first set of machines. By regulating the field exciting voltage of the individual dynamos, the total effect of the system can be allotted to the sets of machines in any desired ratio, for example according to the power of the individual combustion engines. As the working current is the same in all the armatures, the effect of the individual sets of machines depends exclusively on their field excitation. The latter controls the ratio of the total voltage supplied to the system by each set. By the improved method, the sets of machines are started, and the load of the same is regulated exclusively by regulating the shunt field windings of the dynamos, which is done in a convenient and safe way. Main circuit resistances which in other systems are necessary for starting the machines are dispensed with. For regulating the working current from zero to its maximum, or vice versa, only the weak currents of the shunt circuits must be regulated, whereby the safety of the operation is considerably increased.

For changing the field exciting currents in the individual sets of machines after starting the system resistances are not required, but after connecting the field excita-

tions to the armature poles of their respective dynamos such changes can be made by changing the number of revolutions of the cooperating combustion engines, and by thereby changing the self excitation. For practical purposes both methods of regulating the field excitations will be used.

The above described method can be used with good results in generator systems of the character referred to as long as the maximum current required is within certain limits dependent on the size of the brushes of the dynamos. If, however, the intensity of the current required in the system is above this limit, the improved method is varied as follows: By changing the field excitations the operative machines are so regulated that the intensity of their current is zero, whereupon the armatures are connected in parallel, and their voltage is again raised. In this case, while the armatures are connected in parallel, the load of the individual sets of machines can not be regulated to the same extent as in the above described example in which the armatures are connected in series. Instead of the said regulation, the sets of machines are automatically regulated when connected in parallel, so that the energy supplied by the system is almost uniformly distributed among the cooperating sets of machines. This automatic regulation is based on the fact, that high speed combustion engines, such for instance as automobile motors, in which the throttle valve is continuously open, and which are not provided with a throttling speed regulator, upon a change of the momentum caused by an outer influence, change their speed, so that a definite speed corresponds to each momentum, a decrease of the momentum causing an increase, of the speed, and an increase of the momentum causing a decrease of the speed. If, therefore, the dynamos are connected in parallel, an increase of the load of one of the sets of machines as compared to the other sets causes a decrease of the speed of the said set and therefore a decrease of the electromotive force of the same, and, vice versa, a decrease of the load causes an increase of the electromotive force. The changes of the electromotive forces cause corresponding changes of the intensity of the currents supplied by the respective sets in such a way that the load is balanced.

It is not necessary, that the excitation of all the sets of machines be the same. If the excitation of one of the dynamos is too small, the voltage of the same is made equal to that of the other dynamos by automatic regulation of the speed. Should the fuel supply be stopped in one of the combustion engines, no damage can be done, because in such cases the armature current of the said dynamo is reversed. It will therefore be

rotated by the current until the defect is observed, whereupon the dynamo is either thrown out of the operation, or the defect is repaired. The automatic regulation can not
 5 take place without the objectionable "balancing" of the machines, unless the momentum of inertia of the revolving bodies is as small as possible. Therefore the sets of machines must be composed of high speed
 10 combustion engines having no fly wheels and of dynamos which are directly coupled to the said combustion engines.

I claim:

1. A method of operating a current producing system or installation comprising a
 15 plurality of units each consisting of a dynamo and an internal combustion engine coupled therewith, which consists in first starting one unit, exciting the fields of the
 20 successive dynamos to cause them to act as motors and thereby start their respective engines, and then reversing the field excitations of said units when a predetermined speed is attained, substantially as described.

2. A method of operating a current generating installation comprising a plurality of
 25 units each consisting of a dynamo and a prime mover coupled therewith, which consists in first starting one unit, then exciting the field of another unit in such a direction as to cause the dynamo of said unit to act as
 30 a motor and start its engine, reversing the field excitation of said unit after starting, to supply current to the line, and regulating the field excitations of said units in accordance with the amount of energy to be supplied by each unit, substantially as described.

3. In a traveling dynamo system of elec-

tric traction, a current generating installation for the train comprising a plurality of
 40 generating units each of which consists of a dynamo and a prime mover coupled thereto, means to start one of the prime movers by temporarily using the dynamo of such prime
 45 mover as a motor by exciting its field from a suitable source, means to connect the dynamos in series or in parallel, means to reverse the field excitations of the dynamos, and means to regulate the field of each
 50 dynamo to vary the energy supplied by the corresponding unit, substantially as described.

4. In a traveling dynamo system of electric traction, a current generating installation for the train comprising a plurality of
 55 generating units each consisting of dynamo and internal combustion engine directly coupled together, said dynamos being of the shunt-wound type, means to start one of said
 60 engines by exciting the field of its dynamo and thereby causing said dynamo to act as a motor, means to connect the armatures of the dynamos in series or in parallel, means
 65 to connect the field of an inactive dynamo to a dynamo already set in operation, in order to excite such field in either direction, and means to regulate the excitation of each
 70 dynamo field to vary the amount of energy supplied by the corresponding unit, substantially as described.

In testimony whereof I have affixed my signature, in presence of two witnesses.

WILHELM ADOLF THEODOR MÜLLER.

Witnesses:

WOLDEMAR HAUPT,

HENRY HASPER.