

(No Model.)

2 Sheets—Sheet 1.

C. HOFFMANN.
REGULATING PARALLEL CIRCUITED ALTERNATE CURRENT MACHINES.
No. 510,862. Patented Dec. 12, 1893.

Fig. 1.

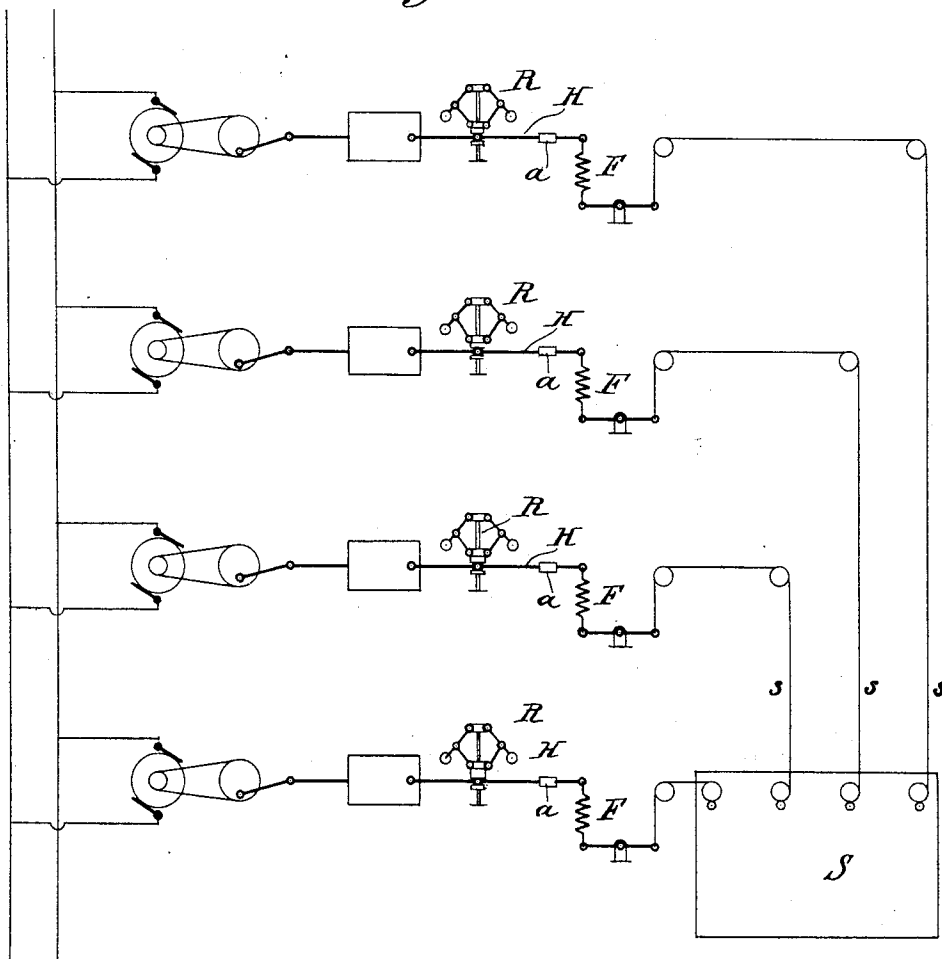
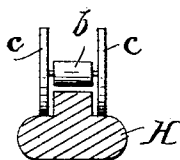


Fig. 3.



WITNESSES:

John H. Deemer
Geo. H. Brundage

INVENTOR

Carl Hoffmann
BY
Robt. H. Benjamin
ATTORNEY

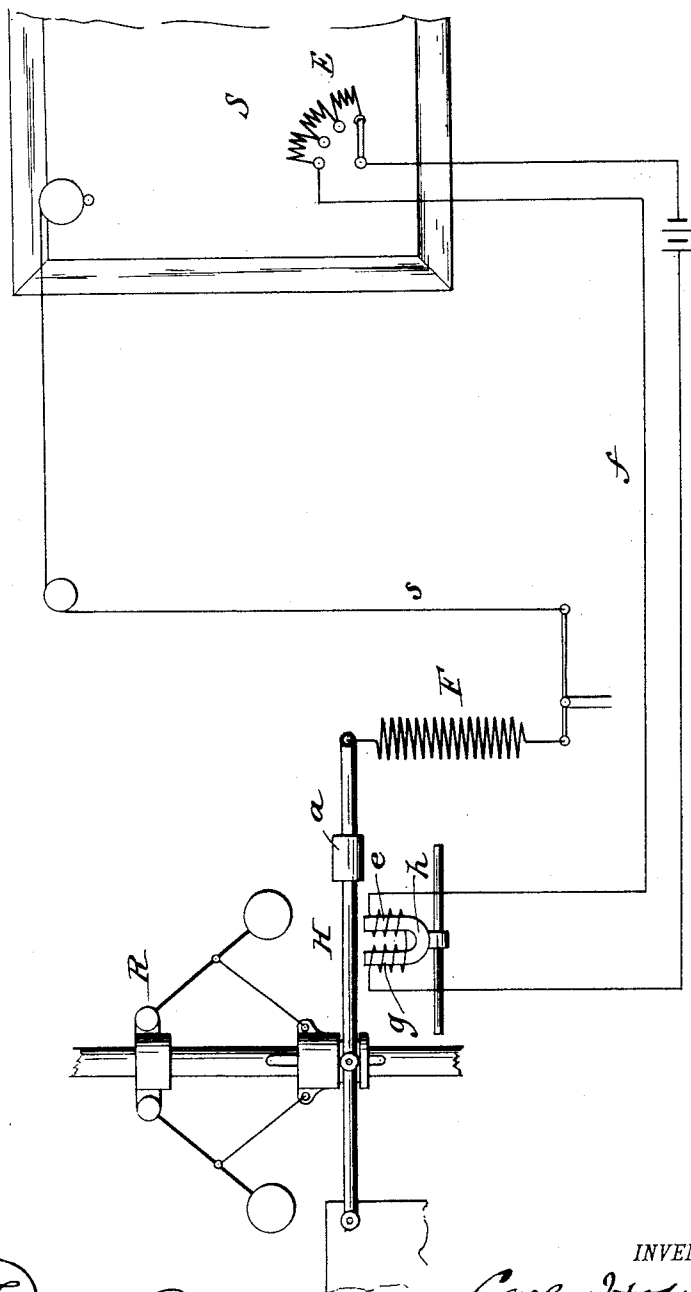
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Fig. 2.



WITNESSES
John B. Deemer
Geo. H. Chandler

INVENTOR
Carl Hoffmann
BY
Geo. H. Benjamin
ATTORNEY

UNITED STATES PATENT OFFICE.

CARL HOFFMANN, OF BERLIN, GERMANY.

REGULATING PARALLEL-CIRCUITED ALTERNATE-CURRENT MACHINES.

SPECIFICATION forming part of Letters Patent No. 510,862, dated December 12, 1893.

Application filed September 28, 1893. Serial No. 486,666. (No model.)

To all whom it may concern:

Be it known that I, CARL HOFFMANN, a subject of the King of Prussia, German Emperor, residing at the city of Berlin, Kingdom of Prussia, German Empire, have invented new and useful Improvements in Regulating Parallel Circuited Alternate-Current Machines, of which the following is a specification.

My invention relates to regulators to be used in systems of parallel circuited alternating current machines, and it has for its object to provide such arrangement and construction of regulators, that they may be operated from a common switch board. Alternating current machines when arranged in parallel circuits must run with perfect synchronism, otherwise the current generated would fluctuate in intensity with the result of an uneven translation and liable injury to the machine. To produce an evenness of rotation in the whole number of machines a number of devices are used, which, however, need not be specially described herein. The effect of the centrifugal regulators is in a certain measure dependent on the demands put upon the steam engines which they regulate; *i. e.*, in other words, if a regulator should regulate to an exactly determined number of revolutions, the load on the steam engine concerned should be perfectly definite. It follows therefrom, that if two alternating current machines are brought to and are maintained in synchronism by centrifugal regulators only, each one of them must have its determined load; or what is the same, the load of one of these machines cannot be voluntarily changed without endangering the synchronism of the system. This defect is especially felt when one machine is to be connected or disconnected with regard to a circuit having already other machines therein connected in parallel. Before a machine is switched in with those already running in parallel, it must be brought to run exactly synchronously with the same. Inasmuch as the old machines are already loaded, and the new one to be switched in is not, the regulators of the switched-in and to be switched-in machines, even though they work normally alike, will in this case not take the same number of revolutions. It is seen therefrom that it is impossible to obtain the necessary syn-

chronism for parallel circuiting by centrifugal regulators alone, *i. e.*, without using further auxiliary means. Something similar is shown when switching out a machine. Before switching out, it is known that the charge of the machine to be switched out must first be reduced to naught, so that its withdrawal from the circuit does not cause too strong a spark at the switch and no sudden interruption of the current distribution. Then, when switching out a loaded alternating current machine the machines which remain switched in easily fall out of synchronism, as their sudden increase in load influences their operation in an entirely different manner, according to the position of the crank of the driving rod, *i. e.*, according to the amount of the pressure at that moment of the machines driving them. As soon as it would be tried to decrease the load of the alternating current machine to be switched out, when like in continuous current machines, the exciting of the magnets is decreased, then the centrifugal regulator of the driving engine would have to take a greater speed of rotation, so as to decrease the admission of steam corresponding to its increased speed; *i. e.*, the synchronism would have to stop. This would also be the case with greater changes of the load; slight changes of the load do not act in this manner, as the known effect of the parallel circuited machines would still be able to keep up the synchronism. As long as the synchronism is extant, the position of the valve controlled by the centrifugal regulator is not changed; *i. e.*, the load could not be noticeably changed, and if there are any changes in the load in the circuit, all machines must participate in an equal manner in these changes of the load. Under these circumstances it is customary to carry out the connecting and disconnecting of alternating current machines in parallel in another manner, whereby the machines when switched parallel or their parallel positions are interrupted only when both machines have corresponding loads, *i. e.*, when the centrifugal regulators of both actually have the tendency to become synchronous, precisely as was formerly done in continuous current machines. For this, however, it is necessary that there be provided an ohmic resistance corresponding to the normal load

of the machine to be switched in or out of the circuit and which is generally not in connection therewith. With this ohmic resistance the changes mentioned can certainly be carried out, but the operation itself requires in the said resistances and their switch devices, such complicated auxiliary means that it is desirable to replace this method of switching by one which is just as easy and still more simple. This can be done in the following manner: The centrifugal regulators of the steam engines driving the current generators are each provided with a regulating device. This device should so act that the centrifugal regulators will allow the steam engines to consume a greater or less quantity of steam with the same speed, so that the load of every machine can be regulated without thereby endangering the synchronism, by so setting the centrifugal regulators that the pressure of steam fed to the machines is changed, as required by the operation. The manner in which this setting of the regulators can be carried into effect will depend upon the circumstances.

Referring now to the drawings herewith forming a part of this specification, and in which similar letters represent similar parts in the several views: Figure 1 is a diagrammatic representation of a series of alternating machines connected in parallel with a supply system, and having steam engines arranged to operate them, said engines having regulating devices arranged and operated according to my invention. Fig. 2 is an elevation of a regulator, its connections with the switch-board, and its engine. Fig. 3 is a detailed view showing the arrangement of a device for altering the delicacy of the mechanism.

Referring now to the drawings, I will describe my method of accomplishing the object as hereinbefore stated.

H is a lever arm to which is fastened a spring F in such a manner as to act on the centrifugal regulators R, that by the variable tension of the spring the counter effect against the centrifugal force is increased or decreased. A running weight *a* can also be so fastened to the lever arm H that by the change of position of this running weight in the one or the other direction (perhaps by an electromotor) the pressure, which this lever arm exercises on the regulators, may be varied. The regulator can then be arranged to be strongly static, preserving its great sensitiveness, so that the number of revolutions of the separate parallel circuited machines will, when the work of the circuit is changed, take their new dead beat condition. If, for instance, the aggregate of the load of the machines is decreased, the regulator of every steam engine will then take a greater speed, thus feeding less steam. Then the regulators are set so that they effect in every engine the same decrease in steam feed with the increase in speed. For the further regulating a change in the strength of the current in the exciting limbs is also necessary, as the tension of the

alternating current machines increases with a constant speed, despite the decrease of their current strength. If the regulator of one of the driving steam engines in a group of parallel circuited alternating current machines is displaced, the effect is that its work is either increased or decreased, as their number of revolutions through the tendency of the alternating current machines remains on the whole the same. Thus, without further trouble the work and simultaneously therewith the current strength of a machine can be brought to naught by the displacement of the centrifugal regulator, and when this point is reached the machine can be switched out. On the other hand, the tension and the number of revolutions of a machine to be switched in, can be brought in this manner to exactly the value of the tension and the number of revolutions of the distributing net work, so that they can be connected with the net work without that it were necessary to previously load the same by a load resistance. To be able to use this method of regulating the operation, it is necessary to so arrange the entire system that the described regulating of all the steam engines can be done from one point and that from that point where all the controlling apparatus of the system are located. For this purpose all setting devices of the centrifugal regulators are so connected with the switch-board S that all the necessary setting of the regulators can be made from that. This centralizing of the above regulating of the entire system of the switch-board is the basic idea of this invention; the manner in which the setting of the centrifugal regulators can be done from the switch-board is self-evident to an expert. The setting can, for instance, be done as shown in Fig. 1, wherein a spring F is more or less drawn from the switch-board by a string *s*; or the position of a movable weight *a*, which is located on a lever arm H, acting on the regulator can be changed by a small electro-motor which is caused to run up and down, from the switch-board. This latter form is more particularly represented in Fig. 3, in which *b* is a weighted motor having wheels *c*, whereby it may be caused to run in either direction on the lever arm H, which in this case is provided with a flat upper surface having a centrally located longitudinal rib to be straddled by the wheels *c* and retain the motor in place upon the arm. The motor *b* may be supplied with a suitable current from the switch-board, a switch being introduced into its circuit to regulate its movement on the arm H. If preferred, however, I may arrange a magnet *e*, shown in Fig. 2, in such a manner that it may be shifted longitudinally with reference to the arm H to which it is in such close proximity as to include it in its field. A suitable source of current may be located conveniently and including in its circuit *f* the windings *g h* of the magnet *e*, and also a variable resistance E for regulating the intensity of the magnetic field.

It will thus be seen that by either the longitudinal shifting of the magnet *e* or by an increase or decrease in the intensity of its field, the freedom of movement of the lever arm *H* may be altered and simultaneously therewith, the delicacy of the regulator. These are, however, details which are within the field of the mechanic. It is evident that this regulating of the steam feed from the switch-board is a very simple and effective means for the regulation of the entire operation. The switching in and out of alternating current machines becomes as simple as was the parallel circuiting of continuous current machines, which can also be completely controlled from the switch-board.

This invention does not consist simply in that the valve regulated by the centrifugal regulator is influenced from the switchboard, as the method is with some modification useful in machines which are not regulated by a centrifugal regulator but by hand. In these machines which may be used only the throttle valve need be provided with a suitable device to set it from the switchboard. By the direct setting of this throttle valve, the same effect is obtained in the desired variations of the load of the machine, which was obtained, according to the first described method, by the setting of the centrifugal regulator and of the valve controlled by the centrifugal regulator. As the previously described method of regulating the operation from the switchboard can be used in exactly the same manner in continuous current machines as in alternating current machines, the following claims extend as well to continuous current machines as to the alternating current distributing plants, specially considered in this specification.

It is considered as being understood, that

not only steam engines, but all other kinds of power machines, whose working can be changed by direct or indirect setting of the valves, can be employed in the central regulating system, for which protection is here asked.

I claim—

1. The herein described method of regulating parallel circuited alternate current machines, and of arranging them in parallel circuit while in operation, which consists in bringing the several machines independently to a determined speed from a common point, through the regulation of the governors of their respective energizing apparatus; subsequently switching them into circuit and finally varying the sensitiveness of the said governors.

2. The herein described method of regulating alternate current machines and of arranging them in parallel circuit while in operation, which consists in bringing the several machines independently to a determined speed through the regulation of the governors of their respective energizing apparatus and subsequently switching them into circuit.

3. The herein described method of regulating alternate current machines and of arranging them in parallel circuit while in operation, which consists in bringing the several machines independently to a determined speed from a common point through the regulation of the governors of their respective energizing apparatus and subsequently switching them into circuit.

In testimony whereof I affix my signature in the presence of two witnesses.

CARL HOFFMANN.

Witnesses:

OSCAR BIELEFELD,
WILHELM SHULTZ.