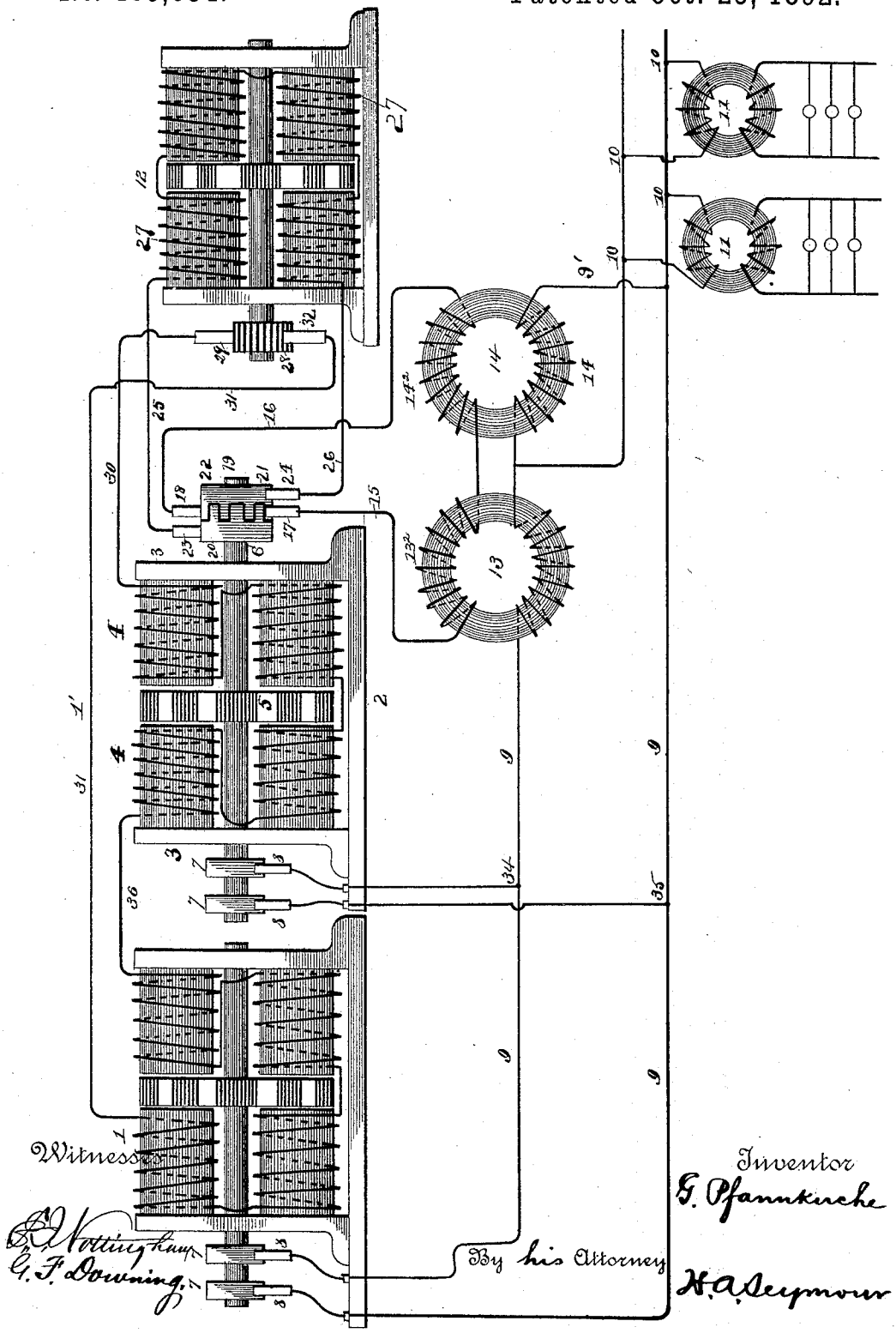
(No Model.)

G. PFANNKUCHE.

REGULATION OF ALTERNATING CURRENT GENERATORS.

No. 485,054. Patented Oct. 25, 1892.



Witnesses:
C. F. Dowining.

Inventor
G. Pfannkuche

By his Attorney
H. A. Seymour

UNITED STATES PATENT OFFICE.

GUSTAV PFANNKUCHE, OF CLEVELAND, OHIO, ASSIGNOR TO THE BRUSH ELECTRIC COMPANY, OF SAME PLACE.

REGULATION OF ALTERNATING-CURRENT GENERATORS.

SPECIFICATION forming part of Letters Patent No. 485,054, dated October 25, 1892.

Application filed November 30, 1887. Serial No. 256,512. (No model.)

To all whom it may concern:

Be it known that I, GUSTAV PFANNKUCHE, of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in the Regulation of Alternating-Electrical-Current Generators; 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.

My invention has reference to improvements in the regulation of alternating-electrical-current generators, whereby the latter become adapted for use in general systems of distribution in which the number of translating devices is variable.

It is more especially designed for use in connection with such systems of distribution in which the translating devices are in multiple-arc branches derived from a main or trunk line and in which it is desired to maintain constant difference of potential at the terminals of the derived branches or working circuits, which are frequently at great distances from the generator. In such systems, as in all systems of distribution, the difference of potential at the brushes of the generator is dependent upon the relation of the external resistance to the total resistance, in such manner that when the external resistance increases the difference of potential at the brushes also increases, while at the same time less current is generated in the armature, and when the external resistance decreases the difference of potential at the brushes also decreases and more current is at the same time generated in the armature. From this it becomes clear that in a multiple-arc system of distribution whenever one or more working branches are opened provision should be made to decrease the strength of the field-magnets, and whenever additional working circuits are closed the strength of the field-magnets should be increased, in order to maintain a constant difference of potential, substantially as in constant-potential dynamos for incandescent electric lighting.

The object of my invention is to accomplish this result automatically and effectively in a separately-excited alternating-current generator or any number of such generators, and I provide for this purpose a separately-excited exciter, which furnishes currents of one direction to the field-magnet coils of the alternating-current generator or generators, and the arrangement is such that the strength of the current furnished is controlled by the difference of potential at the brushes of the alternating-current generator. For this purpose the field-magnets of the exciter are charged by the current generated in the alternating-current generator, which currents, however, are first straightened out by a suitable commutator before they reach the field-coils of the exciter.

The currents furnished by the alternating-current generator or generators are ordinarily of comparatively very high tension, and especially so if they are intended to be used for the operation of induction-transformers or secondary transformers or other like translating devices, and these currents are not well suited for charging the field-coils of the exciter. For this reason, instead of charging these field-coils directly by the currents from the alternating-current generator, I cause these currents to be transformed into currents of suitable lower tension before they reach the commutator above referred to, so that excessive sparking at said commutator is prevented and the current will reach the field-coils of the exciter with such tension as is suited for the functions which it is designed to perform. For this purpose I employ two induction-transformers, the primary coils of which are placed, respectively, in the main line and in a branch derived from the same, so that they will act in the same sense, and their secondary coils will thus yield an integral current depending upon the relation of the external resistance of the line to the total resistance of the alternating-current generator and line combined, and these currents, after being straightened out by the commutator above referred to will charge the field-coils of the exciter, which in turn will charge the field-coils of the alternating-current generator in accordance with the demands of the system. All this will more fully appear from the following detailed description with reference to the accompanying drawing, which

forms a part of this specification and in which I have illustrated the invention mainly in diagram.

In the drawing there is shown alternating-current generators 1′, which may be of any ordinary or improved construction. They are represented in the drawing as mounted upon a base-plate or platform 2, upon which standards 3 3, of iron, are bolted and which standards constitute the yokes of the field-magnets 4 4. The armature 5, which is preferably of the Brush type, is mounted upon a shaft 6, which may be journaled in the standards and is driven in any suitable manner.

The alternating currents generated in these machines, which when started depends for the generation of current upon the residual magnetism of the field-cores, are collected by brushes 8 8, bearing upon the collecting-disks 7 7, secured to but insulated from the shaft and having the terminals of the armature-coils connected therewith. All these parts may be of ordinary construction, well understood by those skilled in the art, and need not be specifically described.

With the collecting-brushes 8 8 the main or trunk line 9 9 is connected, and at distant points 10 10, &c., this line is tapped by multiple-arc branches, in which suitable translating devices are included.

The translating devices 11 11, &c., shown in the drawing are in fact inductoriums designed to divert currents of a given tension into currents of different tension, substantially as set forth in patent to Charles E. Brush, No. 219,209.

The alternating-current generator used in the system here shown is constructed to furnish currents of comparatively very high tension, and the inductoriums or secondary transformers are therefore arranged with their fine-wire coils in the multiple-arc branches 10 10, &c., while their coarse-wire coils include translating devices adapted to be operated by currents of comparatively-low tension, like incandescent electric lamps, &c.

The present system is specially adapted to a circuit employing secondary transformers; but it extends, also, generally to circuits which include any suitable translating devices.

The field-coils of generator 1 are charged by an exciter 12, the field-coils of which are themselves charged by the current from the alternating-current generator 1, as will presently appear.

Two transformers 13 14 of any suitable or improved construction are arranged with their primary coils 13′ 14′, respectively, in the main line 9 9 and in a branch 9′ 9′ thereof, as shown, and the secondary coils 13^2 14^2 are connected in series and by wires 15 and 16, respectively, with brushes 17 18 of a commutator 19, mounted upon but insulated from shaft 6. This commutator is composed of two hollow cylindrical blocks 20 and 21, each provided at one end with a number of segmental teeth 22, alternating with segmental spaces, and these two blocks are so mounted upon the armature-shaft that the teeth of each block engage the corresponding spaces in the other, with insulating material (indicated by heavy lines) intervening between the two blocks. The brushes 17 18 bear on diametrically-opposite sides upon the segmental portion of the commutator, while two brushes 23 24, bearing upon the smooth cylindrical portions of the commutator, are connected by wires 25 26 with the terminals of the field-coils 27 of the exciter 12.

The commutator 28 of the exciter is of ordinary construction for sending straight currents to the external circuit, which starts from commutator-brush 29 and passes by conductor 30 to and through the field-coils 4 4 of the alternating-current generator and returns by conductor 31 and brush 32 to the commutator and to the armature 33 of the exciter. The total number of segments of commutator 19 is equal to the number of alternations of current in generator 1, and these segments are so located upon shaft 6 relative to the coils of armature 5 that one of the brushes 17 18 will bear upon a segment of one of the blocks 20 21, while the other of these brushes will bear upon a segment of the other block during the prevalence of one electrical impulse. It will be now easily understood that the alternating currents from the line reaching the fine-wire coils 13′ 14′ of the transformers 13 14 will generate alternating currents of low tension in the coarse-wire coils, and that these electrical impulses will be straightened out by the commutator 19 and will leave said commutator by one of the brushes 23 24 and return by the other after having traversed the field-coils 27 27 of the exciter. These field-coils are thus in effect charged by currents from the line by induction.

It will be noticed that the primary coil of transformer 13 receives the whole line-current, while the primary coil of transformer 14 only receives a branch of said current through the derived circuit 9′ 9′, and I rely for the regulation of my system upon the combined action of these two transformers.

The automatic regulation to a constant difference of potential at the terminals of working circuits in a system of distribution provided with my apparatus can now be explained. The alternating-current generator and the exciter are started simultaneously, and since the fields of neither of these machines are at that moment separately charged the generation of current in their armatures depends for the time being upon the residual magnetism of their field-magnets, unless provision is made for temporarily charging these field-magnets, as is well understood by those skilled in the art. Upon starting, therefore, the currents will be necessarily weak. The current furnished by the exciter, weak as it is, will be sufficient to energize perceptibly the field of the alternating-current generator, and the currents furnished by the lat-

ter will in turn charge the primaries of the transformers 13 14, the secondaries of which will in turn charge the field-coils of exciter 12. Thus it will be seen that both machines will after a few moments reach their maximum power. This power in the case of the alternating-current generator depends first upon the current furnished by the exciter and then upon the external resistance of the line, while in the case of the exciter its power depends altogether upon the currents passing through the line, and therefore through the primary coil of converter 13, and upon those diverted through the primary coil of converter 14; but it will be understood that the current diverted into the primary coil of converter 14 depends upon the difference of potential at the brush-terminals of the alternating-current generator, and consequently upon the resistance of the line. Supposing now that all of the machines are started when a given number of translating devices like the secondary transformers 11 11 are at distant points, included in the multiple-arc branches from the main line and that in that condition of the system the alternating-current generator furnishes the required current to the line and produces the required difference of potential. If now additional multiple-arc branches 10 10 are introduced, the external resistance of the prime generator will be reduced, and in consequence thereof, as stated above, the difference of potential at the brush-terminals of generator 1 will at once decrease, while at the same time more current will be generated, as required by the increased number of translating devices. In consequence of the increase of current in the line more current will be generated in the secondary coil 13^2 of transformer 13, and in consequence of the decrease of difference of potential less current than before will be diverted through the shunt 9′ 9′ into the fine-wire coils of transformer 14, and less current will be generated in the coarse-wire coils of said transformer; but the conditions are such that the sum total of the current generated in the secondary coils 13^2 14^2 will be increased, thus sending more current to the commutator 19 and to the field-coils 27 27 of the exciter. A stronger current will therefore be generated in armature 33 of the exciter, and the current from brush 29 over conductor 30 to and through the field-magnets 4, conductor 31, back to brush 32, will more strongly excite the field of generator 1, and the difference of potential at the brush-terminals will thereby be raised, as required. Thus it is seen that such change in the external resistance as will tend to decrease the difference of potential at the brush-terminals will automatically operate to re-establish or maintain the original difference of potential. If, on the contrary, some of the multiple-arc branches 10 10 are opened and the external resistance of the line increased, less current will be generated in armature 5, and the difference of potential at the brush-terminals will be increased. As a consequence of this, more current will be diverted through shunt-wires 9′ 9′ into the fine-wire coil of transformer 14, more current will be generated in the coarse-wire coils of said transformer, while the diminished current of the line passing through the fine-wire coils of transformer 13 will generate a diminished current in the coarse-wire coils of the latter. The sum total of the currents generated in the two coarse-wire coils 13^2 14^2, however, will be diminished, and for reasons which are now apparent the strength of the field of generator 1, and therefore the difference of potential at its brush-terminals, will be reduced, thus re-establishing the normal difference of potential.

It is clear that my system will operate to maintain a constant difference of potential whether the change of external resistance is caused by the closing or opening of working branches or by any other cause, for it responds to and reacts upon variations of difference of potential irrespective to the causes which produce or tend to produce the same. No artificially-introduced resistances and no manipulations of any kind are necessary to the effective operation of my invention, which is absolutely automatic.

I desire it to be understood that I do not limit myself to the identical details of construction herein shown and described. These details may be varied and modified at will, so long as the fundamental rules laid down in this specification are adhered to. These rules may be extended to apply without material change to the automatic regulation of the difference of potential in a system of distribution fed by two or more alternating-current generators. I prefer to employ two alternating-current generators 1 1′, which have either a common armature-shaft or have their separate armature-shafts driven at the same speed. The like brushes of these generators are connected together and with the line-wires 34 and 35, respectively, so that the two generators have their armatures coupled in quantity with the main line. The field-coils of the two generators are connected in series by a wire 36, and they are included in the external circuit of the exciter 12. It will be easily understood that any number of alternating-current generators may be thus arranged with their armatures coupled in quantity and connected with the main line and with their field-magnet coils in series with the external circuit of the exciter without departing from the principle of my invention.

Having now fully described my invention, I claim and desire to secure by Letters Patent—

The combination, with a separate exciting-dynamo and a number of alternating-current dynamos having their field-coils connected in series and their armatures in multiple arc and a main or trunk line supplied by said armatures, of two inductoriums having their coarse-wire coils included in circuit with the

field-coils of said exciting-dynamo and their fine-wire coils included one in the main or trunk line and the other in a branch derived therefrom in multiple arc with the working devices in the said main or trunk line and a commutator in the circuit from the last-mentioned inductoriums to the field-coils of the exciting-dynamo, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

GUSTAV PFANNKUCHE.

Witnesses:
ALBERT E. LYNCH,
PAUL KESTER.