K. L. HANSEN.

CONSTANT CURRENT GENERATOR FOR ARC WELDING.

APPLICATION FILED JUNE 27, 1921.

1,418,707. Patented June 6, 1922.

2 SHEETS—SHEET 1.

FIG. 1.

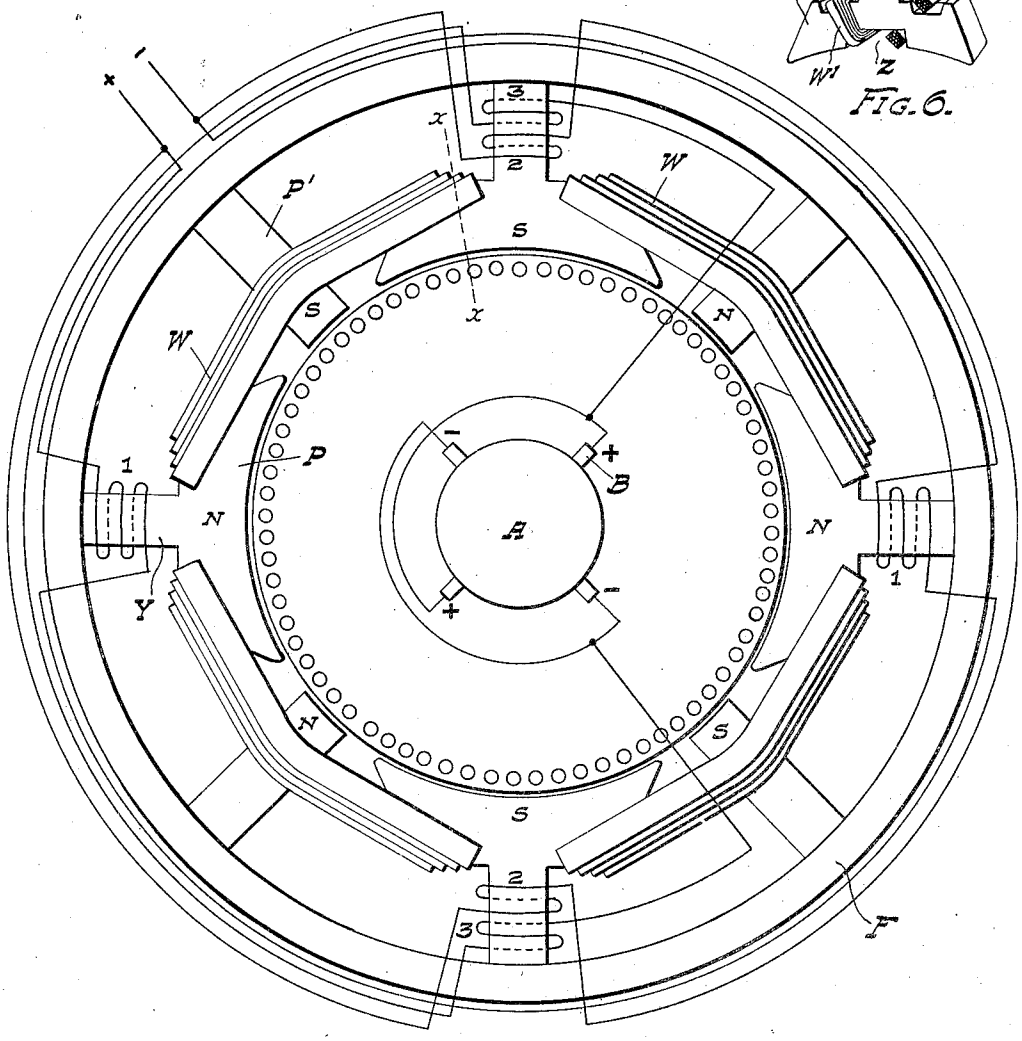


FIG. 6.

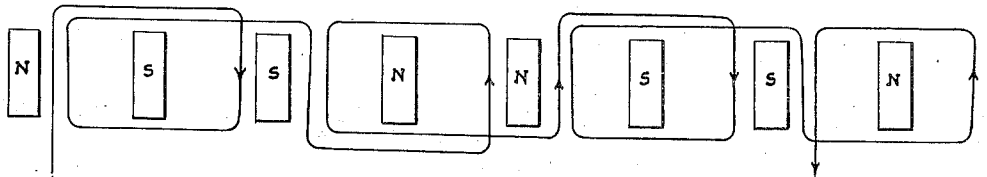


FIG. 3.

WITNESS:

Phil J. Nauss

INVENTOR.

H. L. Hansen.

BY:

Erwin, Wheeler & Woolard,

ATTORNEYS.

K. L. HANSEN.

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2 SHEETS—SHEET 2.

FIG. 2.

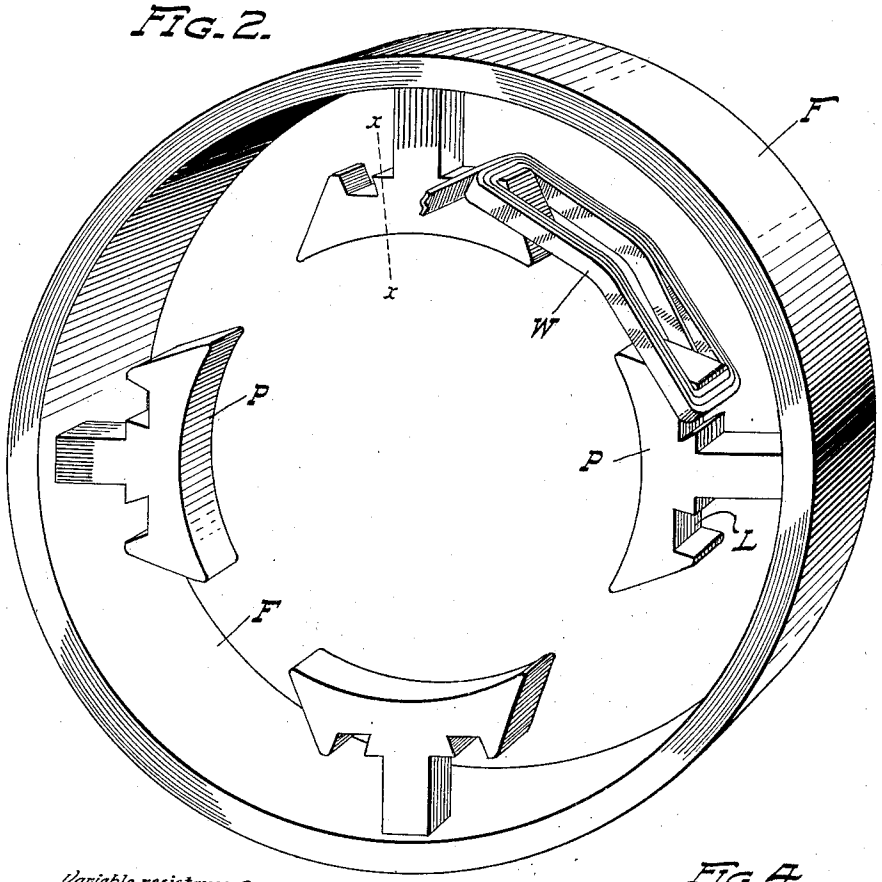


FIG. 4.

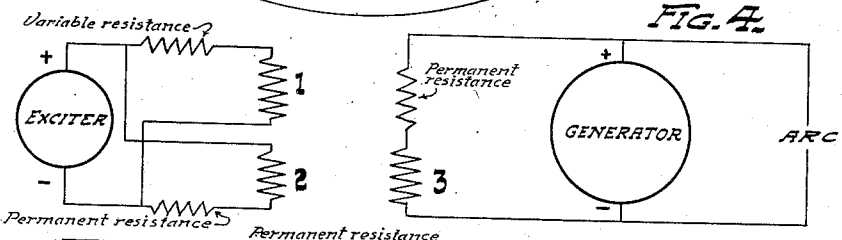
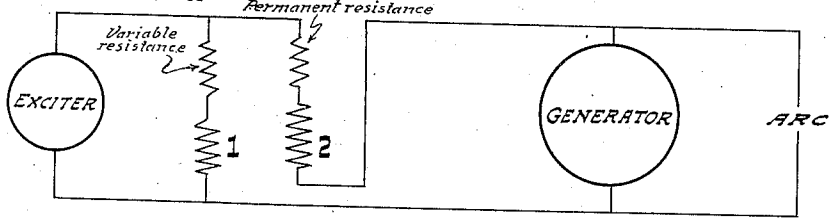


FIG. 5.



WITNESS:

Phil J. Mann

INVENTOR:

K. L. Hansen.

BY:

Ercin, Wheeler & Woodard

ATTORNEYS.

UNITED STATES PATENT OFFICE.

KLAUS L. HANSEN, OF MILWAUKEE, WISCONSIN.

CONSTANT-CURRENT GENERATOR FOR ARC WELDING.

1,418,707. Specification of Letters Patent. **Patented June 6, 1922.**

Application filed June 27, 1921. Serial No. 480,598.

To all whom it may concern:

Be it known that I, KLAUS L. HANSEN, a citizen of the United States, and a resident of the city of Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Constant-Current Generators for Arc Welding; and I do declare the following to be a clear, exact, and complete description thereof, such as will enable others skilled in the art to which the invention relates to make and use the same, reference being had to the accompanying drawing as illustrating some forms in which the invention has been embodied.

This invention relates to electric generators, and more particularly to continuous current generators, adapted to maintain substantially constant an electrical condition, such as current or voltage, of its output circuit, under operating conditions tending toward instability of such electrical condition.

In numerous classes of industrial service, of which are welding may be taken as exemplary, the output circuit of the energy supplying generator is subjected to sudden and wide variations in resistance, which tend to cause corresponding fluctuations in the current of such circuit, whereas, for suitable operation of the arc electrodes, or other devices, to be supplied with electrical energy from such circuit, it is necessary or exceedingly desirable that the current be maintained at least substantially constant.

Thus, it has heretofore been proposed to utilize such variations in resistance of the load circuit for causing corresponding variations in the supplied voltage, and where the resistance variations are comparatively slow and gradual, it is possible to maintain the supplied current substantially constant by such means. However, where, as in arc welding, the resistance variations are relatively rapid and wide, it is not possible in this manner to prevent momentary current fluctuations of such magnitude as seriously to affect the welding or other desired action.

The reason for the presence of these fluctuations in the generated current is that, owing to inertia of the stored electro-magnetic energy of the field, the field flux, which governs the generator voltage, cannot change with sufficient rapidity from one value to another in response to the resistance variations.

However, as will hereinafter appear, the character of the control thus effected may be materially improved by reducing the value of the main field flux, with consequent reduction in the electro-magnetic inertia due thereto.

In order to lessen the aforementioned current fluctuations, it is customary to include a reactance in the load circuit, and while this expedient is of material assistance in stabilizing the current value, the same is attended with numerous disadvantages, among which may be mentioned added cost and weight of equipment, and reduction in efficiency due to energy losses.

The present invention has among its objects that of providing for stabilizing the electrical output, particularly the current of generators employed in the foregoing and similar service, while at the same time obviating the aforementioned difficulties and disadvantages of prior structures.

A further object is that of providing a generator having such operative characteristics as to effect the desired stabilizing action without necessitating the use of exterior reactance, or the like.

Other objects and advantages will hereinafter appear.

According to the present invention, it is proposed to modify the design and construction of the generator in several respects, each of which may produce its individual effect for promoting the desired stability, and such modifications being moreover interactive when conjunctively employed.

Thus, it is proposed to effect a very material increase in the number of armature turns in series from brush to brush over the number ordinarily employed, thereby permitting a corresponding reduction in value of the main field flux, with similar reduction in the electro-magnetic inertia of the field, whereby, as hereinbefore stated, the generator is enabled to respond more promptly to fluctuations in resistance of the load circuit.

Further, such increase in the number of armature series turns, serves to increase the self-inductance of the armature, thereby securing the familiar effect of an inductance

or reactance in the load circuit, without requiring the use of special devices connected in the exterior circuit for such purpose.

Again, it is proposed to modify the structure of the generator field member, to adapt the latter to act under the relatively weakened main flux.

It is further proposed to provide the field member with special coils for increasing the distortion of the main field, due to the effect familiarly known as cross-magnetization, to thereby correspondingly increase the reactance of the load circuit.

Finally, it is proposed to utilize certain special arrangements of main field coils, having reference to the several possible sources of energization thereof.

In the drawings which accompany this specification,

Figure 1, is an end view of a generator embodying the invention, certain structural features being shown in elevation, and the circuit connections being illustrated diagrammatically.

Fig. 2 is a perspective view illustrating structural features of the main poles of the generator more in detail, and the auxiliary windings thereon.

Fig. 3 is a diagrammatic view illustrating the circuit of the auxiliary windings about the commutating poles of the generator.

Fig. 4 is a diagrammatic view illustrating the wiring of the generator; and

Fig. 5 is similar view illustrating a modification of the wiring.

Fig. 6 shows a modification in the construction of the main pole shoe and the auxiliary winding.

Referring to Figs. 1 and 2 of the drawings, the same illustrate a generator having an armature A and field elements indicated generally at F, the said armature being multipolar, as indicated in the illustration by the several brushes B, of which four are shown, and said field being similarly provided with four main pole members indicated at P, and also with a like number of auxiliary or commutating pole members, indicated at P′. Each of said commutating poles is located between a pair of adjacent main poles, and the several polar structures are provided with individual magnetizing coils to be connected in circuit in such a manner to constitute successive main poles and successive commutating poles of opposite polarity, each commutating pole being necessarily of the same polarity as the next adjacent main pole, reckoned in this direction of rotation of the armature.

The armature A may be substantially of standard construction, except that the number of series turns thereof is materially increased over the number ordinarily employed for analogous service conditions as and for the purposes hereinbefore described. Such increase in the armature series turns also necessarily requires an increased number of coil turns about the commutating poles to provide the necessary higher magnetization of said latter poles, for insuring perfect commutation and providing a suitable total field strength.

Thus to meet the necessary flux and space requirements, the shoes of the aforementioned main poles are preferably constructed of a radial depth which should be substantially equal to the circumferential extent of the individual main polar pieces as indicated by the line x—x, in Figs. 1 and 2. The portion of the main pole pieces adjacent the field frame may however be of reduced cross section, as illustrated and indicated at Y, owing to the previously mentioned reduction in the main field flux.

Since, as before described, it is proposed herein to increase the field distortion due to cross magnetization, the means now to be described are provided for augmenting or accentuating the cross-magnetization flux.

To such end, auxiliary reactance accentuating windings W, which are preferably composed of flat copper wires, are arranged upon the frame side of the main pole shoes, said coils being maintained between the adjacent main pole pieces in a relation to surround the intermediate commutating pole piece and being supported by means of suitable slots L, teeth or other devices, formed upon the sides of the main pole pieces remote from the armature. The said windings are connected in series with the armature, and in a relation which is such that the current through each winding flows in a direction opposite to that of the current of the armature conductors located therebelow, thus combining with such latter current to effect magnetization of the commutating as well as the main pole shoe. The direction of the resultant magnetomotive force is of course at right angles to that of the main flux whereby the distortion of the main field is very materially increased, with corresponding increase in the reactance.

The auxiliary windings referred to serve additionally to support and strengthen the commutating field flux, whereby the number of turns employed to generate such flux may be correspondingly reduced below that otherwise required. The auxiliary winding may be distributed or concentrated, imbedded in slots, or placed on the surface of the pole pieces, as best suits the conditions, but is preferably embedded in slots, as shown, because the magnetic flux encircling the embedded portion of the coil is thereby greatly increased. The flux interlinking with this winding may be further increased by closing the slot opening with magnetic material. The flux interlinkages may also be increased by surrounding the portion of

the coils not embedded in the slots wholly or partly with magnetic material. The reactance of the load circuit may then be increased to any extent likely to be found desirable in practice, and the necessity for an external reactance is thereby obviated.

The volt-ampere characteristic of the machine is shown in Fig. 1 of a paper presented by the inventor at the 36th annual convention of the A. I. E. E., at White Sulphur Springs, in July, 1920, Transactions, Vol. XXXIX, to which paper reference may be had for a more complete statement as to the operation of the machine than is necessary in connection with the present disclosure.

It has been demonstrated in the said paper that an approximately constant current characteristic may be obtained by employing for the generator a separately excited field, a self excited field and a differentially wound series field. Under such conditions in order to obtain the desired characteristic it is necessary to provide the circuit of the self excited field with resistance of a value such that it is equal to the number of turns per pole of the self excited field, the proportionality factor being such that when multiplied by the net ampere turns per pole the product is equal to the number of volts generated in the armature.

The constant current characteristic could obviously be obtained by a separately excited field and a self excited field, but would be undesirable for two reasons: First, because the self excited field is operated so near the unstable point, as explained, the generator would be sluggish in response to changes in the external resistance. Second, the ampere-turns of the separately excited field would be so small as to make the adjustment of current in the arc circuit difficult.

To overcome these difficulties I propose to make the generator essentially separately excited by means of two separately excited fields opposing each other, and the excitation of one made to vary inversely with the resistance of the arc circuit. The excitation, which actually produces the voltage in the machine, being taken from an external source, time constants of the fields can be made favorable to quick response by means of resistors in the field circuits, as explained in the paper.

In Fig. 1 of the drawings is shown one way in which this can be accomplished. Fields #1 and #2 are separately excited and opposed to each other. Field #3 is self excited and opposed to #2. Preferably, but not necessarily, fields #1 are placed on opposite poles and fields #2 and #3 on the remaining poles, as shown in the said Fig. 1.

On open circuit, when field #3 has its full strength, it practically neutralizes field #2 and leaves field #1, which furnishes excitation for the open circuit voltage. On short circuit, field #3 is reduced to zero, and field #2 now opposes field #1, field #1 being just sufficiently in excess of field #2 to obtain the desired current in the generator circuit. For any intermediate point field #3 will be partly excited in such a way as to maintain a substantial constant current.

Fig. 3 is a diagrammatic sketch showing the resistors which are adjusted to give favorable time constants to the circuits.

In Fig. 4 the same principle is carried out with a different arrangement. Here fields #2 and #3 are combined in one. Fields #1 and #2 are opposed to each other, and while field #2 is essentially separately excited, its strength obviously varies inversely with the resistance of the arc circuit.

In Fig. 6, I have shown a modification of the construction of the main pole pieces, indicated P^2, together with a modification in the arrangement of the auxiliary winding thereon. This construction may be resorted to in case it be desired to increase the reactance without affecting the commutating pole circuit, the conductors of the reactance augmenting winding W^1, being looped around the main pole shoe, and lying in a slot Z formed in the face thereof. A single such slot will accommodate the windings about the horns of the main pole.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States, is:—

1. In an arc welding generator, an armature having an increased number of turns, a field provided with main poles and commutating poles, and auxiliary windings extending from adjacent main poles about the commutating poles to distort the main field and increase the reactance of the load circuit.

2. In an arc welding generator, an armature having an increased number of turns, a field provided with main poles and commutating poles, arranged in alternation, the several poles being provided with magnetizing coils connected to constitute successive main poles and successive commutating poles of opposite polarity, and auxiliary windings extending from adjacent main poles about the commutating poles to distort the main field and increase the reactance of the load circuit.

3. In an arc welding generator, an armature having an increased number of turns, a field provided with main poles and commutating poles arranged in alternation, and auxiliary windings in series extending from adjacent main poles about the intervening commutating poles to distort the main field and increase the reactance of the load circuit.

4. In an arc welding generator, a field comprising main poles and commutating

poles arranged in alternation, the main poles shoes being slotted for the reception of auxiliary windings, and auxiliary windings in series laid therein and extending from adjacent main poles about the commutating poles, in combination with an armature provided with an increased number of turns, whereby the reactance is increased and the welding current, stabilized.

5. In an arc welding generator, an armature having an increased number of turns, a field provided with main poles with pole flanges proportioned relative to the main pole body, substantially as set forth, a reactance augmenting winding, a magnetic field comprising a field of substantially constant excitation, and an opposing field the excitation of which varies inversely with the resistance of the arc circuit.

6. In an arc welding generator, an armature having an increased number of turns, a field provided with main poles and commutating poles, the flanges of said main poles being proportioned relative to the main pole body, substantially as set forth, to increase the reactance of the armature and reduce the self inductance of the main field, and thereby stabilize the current in the welding circuit.

7. In an arc welding generator, an armature having an increased number of turns, a field provided with main poles and commutating poles, and auxiliary windings about the flanges of the main poles, to distort the main field and increase the reactance of the load circuit.

8. In an arc welding generator, an armature, a field provided with main poles and commutating poles, a commutating winding around the commutating poles, all or part of said winding extended to the adjacent main poles, the extended portion of said winding being surrounded in whole or in part by magnetic material to increase the magnetic flux encircling the extended portion of said winding, and thereby increasing the reactance of the load circuit.

9. In an arc welding generator, an armature, a field composed of main poles and commutating poles, a magnetic field comprising a field of substantially constant excitation and an opposing field the excitation of which varies inversely with the resistance of the welding circuit.

10. In an arc welding generator, an armature, a field composed of main poles and commutating poles, a magnetic field comprising a field of substantially constant excitation and an opposing field the excitation of which varies inversely with the resistance of the welding circuit, the magnetic field being established by windings connected to an independent source and to the generator terminals through a plurality of permanent resistors for stabilizing the welding current and a variable resistor for adjustment of the current in the welding circuit, substantially as shown.

11. In an arc welding generator, an armature, a field composed of main poles and commutating poles, a magnetic field comprising a field of constant excitation and an opposing field the excitation of which varies inversely with the resistance of the welding circuit, the said opposing field consisting of a field of substantially constant excitation, this latter field being opposed by a field the excitation of which varies directly with the resistance of the welding circuit.

12. In an arc welding generator, an armature, and a field composed of four main poles and commutating poles, a magnetic field comprising a field of constant excitation the windings whereof are placed on diametrically opposite main poles, and an opposing field the excitation of which varies with the resistance of the welding circuit, the windings of which are placed on the intervening poles.

In testimony whereof, I have signed my name at Milwaukee, this 18th day of June, 1921.

K. L. HANSEN.

Witnesses:
W. F. WOOLARD,
R. S. WITTE.