No. 638,679. Patented Dec. 5, 1899.

T. H. HICKS.

ALTERNATING CURRENT GENERATOR.

(Application filed Jan. 2, 1895.)

(No Model.) 2 Sheets—Sheet 1.

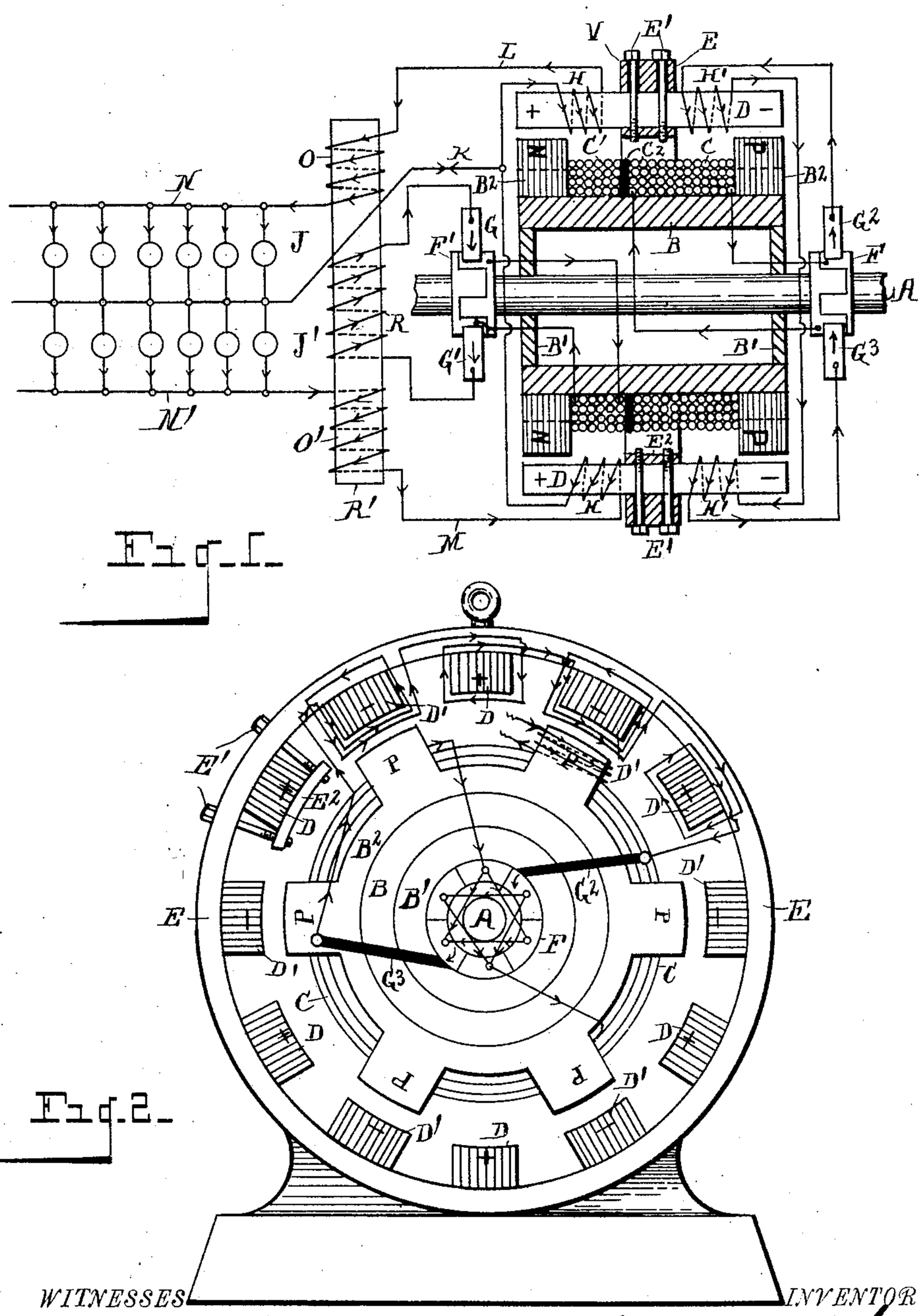

Fig. 2.

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Fig. 3.

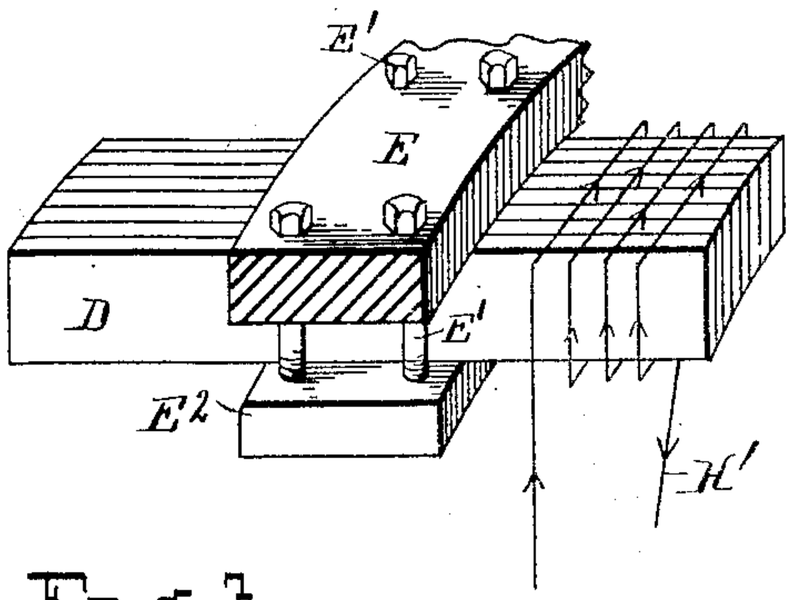


Fig. 4.

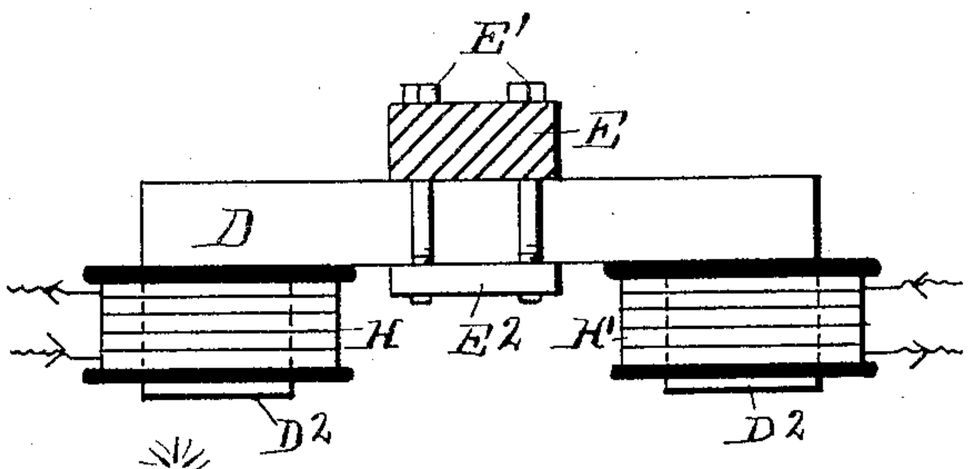
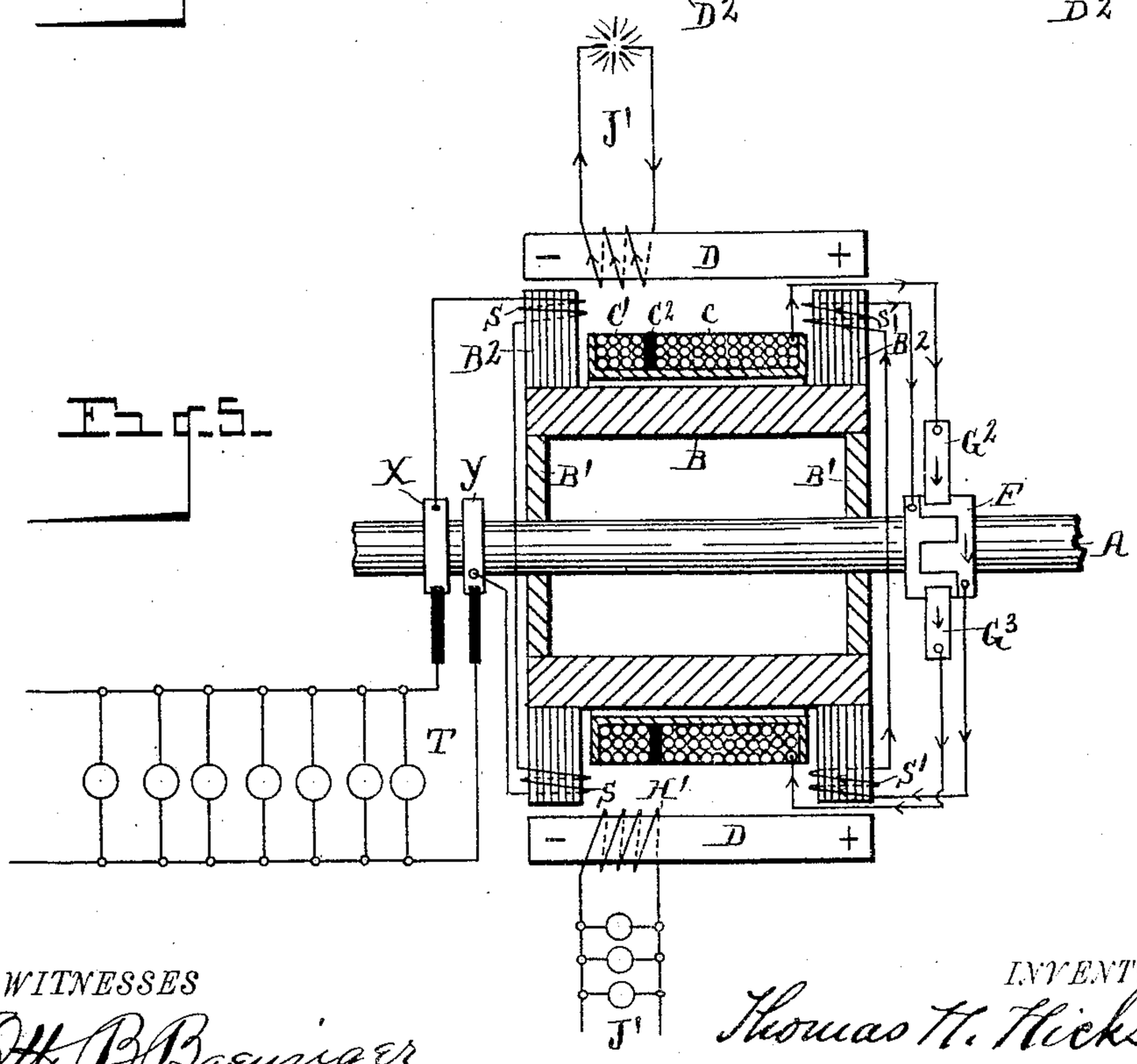


Fig. 5.



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THOMAS H. HICKS, OF DETROIT, MICHIGAN.

ALTERNATING-CURRENT GENERATOR.

SPECIFICATION forming part of Letters Patent No. 638,679, dated December 5, 1899.

Application filed January 2, 1895. Serial No. 533,668. (No model.)

To all whom it may concern:

Be it known that I, THOMAS H. HICKS, a subject of the Queen of Great Britain, residing at Detroit, county of Wayne, State of Michigan, have invented a certain new and useful Improvement in Alternating-Current Generating and Regulating Apparatus; and I 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, reference being had to the accompanying drawings, which form a part of this specification.

My invention relates to an improvement in alternating-current generating and regulating apparatus; and it consists in a compounding arrangement for an alternating-current generator furnishing current to a three-wire system consisting of the induction-coil for furnishing an auxiliary exciting-current to the generator, said induction-coil comprising an iron core, two primary coils on said core, each in series with one of the mains, and a secondary furnishing the auxiliary exciting-current, as will be more fully described hereinafter.

My invention is fully explained in all of its details in the following specification and is equally as fully illustrated in the accompanying drawings hereto annexed. Said drawings are partly diagrammatic for the purpose of a more easy method of exposing the essential parts; but the nature of my scheme will be readily understood by those skilled in this art by reference to the specification and drawings as presented, some parts of the machine being cut away, which will be readily understood.

Figure 1 is a horizontal view, partly in section, and shows the shaft cut off at each end and shows also in diagram two multiple-series work-circuits having three main-line conductors leading thereto and an induction-regulator in connection therewith. The sectional parts of this figure referred to are (*a*) a rotatable field-magnet and its windings (*b*) and an annular ring E, which supports the armature-cores. The parts cut away in Fig. 1 expose to view the two armature-windings and one view of the internal construction of the field-magnet as mounted upon the shaft and also the manner in which the armature-cores are secured in place by the two rings E and E^2 and bolts E′. Fig. 2 is an end view of Fig. 1 and serves to show also an end view of certain parts of Fig. 5. Fig. 3 is a perspective view of one of the armature-cores seen in Figs. 1 and 2, showing a few convolutions of wire near one end of the core. This figure also shows the manner of securing each armature-core in the machine. Fig. 4 is a detail view, partly in plan and partly in section, showing a modification of an armature-core and its coils. Fig. 5 is a similar view to Fig. 1, but showing a modification.

Like letters of reference indicate like parts in the different figures.

I describe the modification shown by Figs. 1, 2, and 3 as follows: A is a shaft. B is an axial cylindrical field-magnet core secured to the shaft by non-magnetic flanges B′ B′. B^2 B^2 are magnetic laminated flanges, being secured to the circumference of the cylinder B at its two ends. These flanges B^2 have multipolar extensions P and N, which are seen to better advantage in Fig. 2. C and C′ are two sets of field-magnet coils, which are shown separated by an insulating-disk C^2, the two sets being wound over the core B, so as to rotate therewith. D and D′ are two sets of laminated armature-cores arranged alternately with each other around the field-magnet parallel to the shaft. Each core is composed of a number of sheet-iron laminæ secured to an outer central supporting-ring E by bolts E′ and segments of an inner ring E^2. Each laminated armature-core is thus held between two circular surfaces which form each core in a circle agreeing with the circle of the inner surface of the outer ring, the latter being in conformity with the diameter of the rotatable field-magnet poles.

The armature-cores may be formed of either straight pieces, as I show in Figs. 1, 2, 3, and 5, or they may be formed so as to have inwardly-arranged polar extremities D^2, as I show in Fig. 4. In either case the conductors may be wound upon the cores in any suitable manner.

In Fig. 2 I only show one armature-core secured, as above stated, to the ring E; but it

will be understood, however, that each core is intended to be secured in a similar manner to the one shown. In this figure also I only show four cores wound with a conductor, simply enough being shown to illustrate the method of winding and connecting the conductors in series with each other through the commutator and to show the natural relative direction of the flow of current impulses.

F and F′ are two ordinary rectifying current-commutators, each consisting of two sets of segments alternately arranged with each other.

G and G′ are brushes for the commutator F′, and G^2 G^3 are the brushes for the commutator F.

In Fig. 1 I show two armature-circuits H and H′, the circuit H′ being to primarily excite the machine to generative action and the circuit H for supplying the three-wire work-circuits J and J′; but it will be readily understood that the machine can be excited to primary action from a separate generator. The armature-circuit H is divided by a compensating conductor K, which leads off as a branch directly to the work-circuit, and thereby forms the third conductor of the work-circuit. The outer two terminals L and M of this armature-circuit H are connected to the work-circuit conductors N and N′, respectively, as indicated, through series-converter regulating-coils O and O′.

R is an induction-coil wound upon the core R′ of the converter for supplying the supplemental or second set of field-coils C′, which is for regulating the pressure of the work-circuit. The current from the induction-coil R is rectified by the commutator F′.

In the modification I show in Fig. 5 the field-coils are stationary, while the field-magnet iron rotates. I also show in this figure two sets of induction-coils wound upon the rotating field-magnet iron, one set being marked S and the other set S′. The induction in these coils S and S′ takes place from the armature-cores D and D′ in the following manner: The field-magnet polar extensions P N, upon which the coils S and S′ are wound, form nearly-closed magnetic circuits through the stationary armature-cores whenever they are in the same radial line with each other. At this time the maximum number of lines of force will flow through this nearly-closed magnetic circuit, thereby inducing a corresponding strength of current in the coils S and S′ in one direction, and when the polar extensions P N have moved so as to be between two armature-cores then the maximum number of lines of force will flow through the poles P N, thereby inducing a current in an opposite direction. At the same time I can also take off induced currents from conductors coiled upon the armature-cores D and D′, which I show supplying the two work-circuits J and J′. I also show a work-circuit T supplied with current from the two rings *x y;* but of course the regulating induction shown in Fig. 1 can be readily applied to this modification also.

The essential feature of my construction lies in the method of supplying a three-wire work-circuit with alternating currents obtained from only one armature-winding and at the same time have the currents of the two sets of multiple-series translating devices act conjointly in inducing a secondary current into the coil R of the transformer for supplying a supplemental set of field-coils, the current of which is for the purpose of regulating the pressure of the three-wire work-circuit.

Taken as a whole my scheme embraces a self-exciting self-regulating three-wire work-circuit machine. I would have it understood, however, that the primary exciting-coil C can be supplied with current from any desired separate source without essentially changing the remaining described features of my scheme.

The complete device operates as follows, directing attention to Figs. 1 and 2: The relative directions of the flow of current in all of the circuits are indicated by arrow-heads arranged upon each circuit. When the field-magnet has been caused to rotate with sufficient speed, the machine then becomes self-exciting through the combined effects of the field-coil C, armature-circuit H′, and the commutator F in the manner well understood by those skilled in this art. If work be then equally turned on the two work-circuits J and J′, current will then flow from the armature-circuit H through conductor L, series coil O, conductor N, translating devices of the two circuits J and J′, conductor N′, series coil O′, and conductor M, where it returns to the armature-circuit H. During such a flow of current the equivalent of the consumed energy in the two coils O and O′ will have been transferred as an induced current in the coil R, which will become rectified by the commutator F, and then caused to flow through the supplemental field-coil C′, which will compensate for any fall of potential in the work-circuit in a manner well understood. If all of the work be now turned off from either the circuits J and J′, the current which flows through the remaining active translating devices will then return to one-half of the armature-circuit H by the compensating conductor K, or if any portion of the translating devices be cut out of one of the work-circuits current will then also flow through the conductor K in a manner similar to a continuous current flowing through any three-wire work-circuit now in common public use. The induced current in the coil R, however, will always be proportional to the current flowing through the two circuits J and J′—that is to say, if ten amperes were flowing through both of the circuits J and J′ the induction in the

coil R would then be twice as great as if the ten amperes only flowed through one of the work-circuits J or J', and as the fall of potential of the work-circuit will always be proportional to the total consumption of electrical watts in the translating devices therefore the current from the coil R will always be suitable for maintaining constant potential in either one or both circuits J or J' in a manner which will be readily understood. To carry out this part of my scheme, I therefore require more than an ordinary three-wire work-circuit, for in addition thereto I require a converter having two sets of series coils O and O', an induction-coil R and its commutator, and an armature-circuit divided by a compensating conductor K into two parts; but it is not essential, however, that the armature-circuit be equally divided into two parts by the third or compensating conductor K.

My scheme is very valuable for isolated plants.

The form of armature-core I show in Fig. 4 is more expensive to construct; but to offset this the coils H and H' are more favorably situated for receiving induction. During rotation of the field-magnet the directions of the flow of the induced current in the two sets of armature-coils are always in opposite directions to each other. Therefore the coils require to be connected together, as I indicate in Fig. 2. The magnetic poles of one sign are of course situated so as to only rotate by one end of each armature-core. In doing this as the field-magnet poles P and N recede from one set of armature-cores they are approaching the other set, and when the poles are equidistant from the two sets of armature-coils induction then becomes equal in the two sets, but of opposite direction around the two sets of cores.

Notwithstanding the fact that I have shown the field-magnet core B to consist of a drum, still it could be composed of solid iron mounted directly upon the shaft without the flanges B. In such a case, however, the bearings for the shaft would require to be composed of non-magnetic material.

Having thus described my invention, and in accordance therewith, I claim as new—

1. In combination with a work-circuit having three main-line conductors and its translating devices arranged in multiple-series system, of a regulating-inductorium having two sets of series coils O and O', one of said series coils being connected to one of said work-circuit conductors and the other of said series coils being connected to another of said work-circuit conductors, a generative armature-circuit having three conductors L, M and K leading therefrom, one of said armature-conductors being connected to one of said inductorium series coils, another of said armature-conductors being connected to the other of said inductorium series coils, and the third armature-conductor being connected to the third work-circuit conductor, substantially as described.

2. In combination with a work-circuit having three main-line conductors and its translating devices arranged in multiple-series system, of a regulating-inductorium provided with two sets of series coils O and O', and with an induction-coil R, one of said series coils being connected to one of said work-circuit conductors and the other of said series coils being connected to another of said work-circuit conductors, an alternating-current generator provided with a supplemental field-magnet coil C', said generator having an armature-circuit provided with three conductors leading therefrom, said generator also being provided with a rectifying-commutator, said field-magnet coil being connected in electrical circuit with said inductorium induction-coil, one of said armature-conductors being connected to one of said inductorium series coils, another of said armature-conductors being connected to another of said inductorium series coils, and the third armature-conductor being connected to the third work-circuit conductor, said commutator rectifying the induced current from said induction-coil for controlling the field of force of said generator, substantially as described.

3. In combination with a work-circuit having three main-line conductors and its translating devices arranged in multiple-series system, of a regulating-inductorium provided with two sets of series coils O and O', and with an induction-coil R, one of said series coils being connected to one of said work-circuit conductors and the other of said series being connected to another of said work-circuit conductors, an alternating-current generator provided with two sets of field-coils, two commutators, and two generating armature-circuits, one of said armature-circuits having three conductors L, M and K leading therefrom, one of said armature-conductors being connected to one of said inductorium series coils, another of said armature-conductors being connected to another of said inductorium series coils, and the third armature-conductor being connected to the third work-circuit conductor, said inductorium-coil R being in electrical circuit through one of said commutators and through one of said sets of field-coils, the said commutator rectifying the induced current from said induction-coil, the other of said generating armature-circuits and the other set of field-coils being connected in electrical circuit through the other of said commutators, the generator being excited to primary generative action through said second set of armature-windings, said second set of field-coils and said commutator in electrical circuit therewith, substantially as described.

4. In combination with an electric generator having three main-line conductors N, N′ and K leading therefrom, an inductorium provided with three sets of coils O, O′ and R, said coils O, O′ being arranged in linear series with the conductors N, N′ and being caused to induce currents into the coil R, either separately or conjointly, and means being provided for rectifying the current of the coil R, substantially as described.

In testimony whereof I sign this specification in the presence of two witnesses.

THOMAS H. HICKS.

Witnesses:
N. S. WRIGHT,
O. B. BAENZIGER.