

O. M. CORBINO.
 TRANSFORMATION OF POLYPHASE CURRENTS INTO PRACTICALLY CONSTANT DIRECT CURRENTS.
 APPLICATION FILED JAN. 7, 1918.

1,390,504.

Patented Sept. 13, 1921.

2 SHEETS—SHEET 1.

Fig. 1.

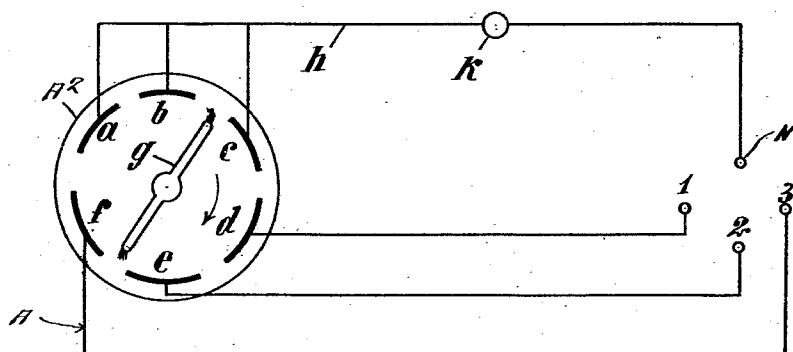
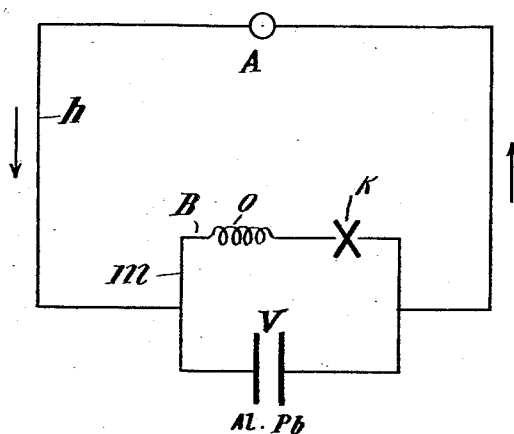


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 3.

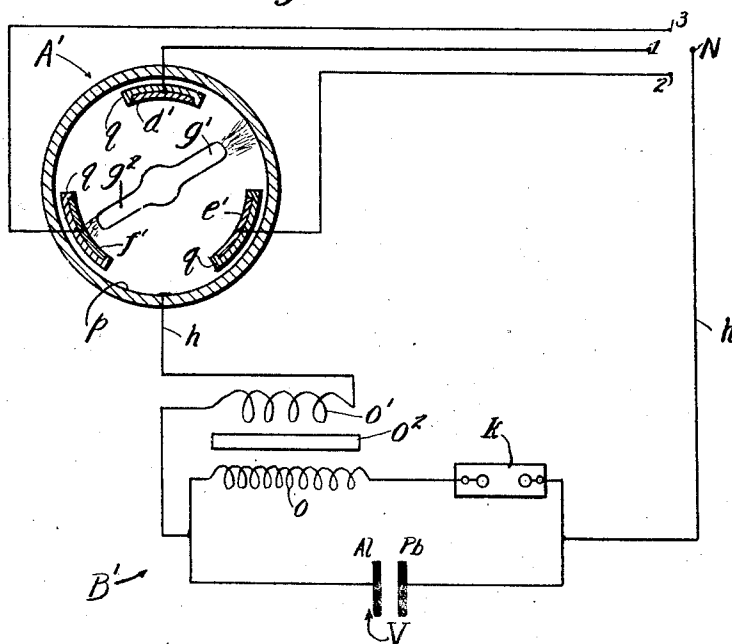


Fig. 4.

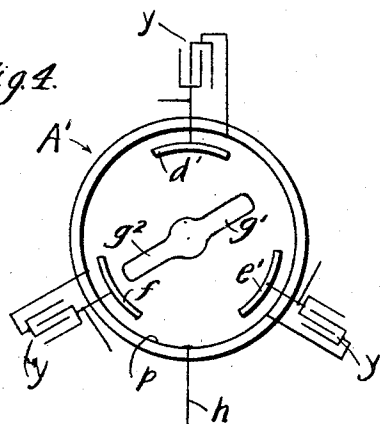
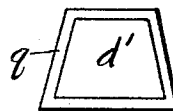


Fig. 5.



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TRANSFORMATION OF POLYPHASE CURRENTS INTO PRACTICALLY CONSTANT DIRECT CURRENTS.

1,390,504.

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Application filed January 7, 1918. Serial No. 210,716.

To all whom it may concern:

Be it known that I, ORSO MARIO CORBINO, of Rome, in the Kingdom of Italy, have invented certain new and useful Improvements in Transformation of Polyphase Currents into Practically Constant Direct Currents, of which the following is a full, clear, and exact specification.

The present invention refers to an apparatus for transforming alternating monophase or polyphase currents into practically constant direct currents, the transformation being accomplished in two successive steps.

In the first of said steps the alternating monophase or polyphase currents are converted into unidirectional intermittent current, that is to say into a current constituted by the succession of separate impulses flowing all in the same direction which are cyclically supplied by each of the phases, during a certain fraction of the complete wave. The duration of the said impulses, the choice of the particular fraction of the wave utilized, and the durations of the pauses between successive impulses are determined in such manner as to meet the requirements of the particular circumstances in each case.

In the second step the intermittent or pulsating current, generated at the first step, is transformed into continuous direct current, of practically constant intensity. This result is obtained by partially storing in a potential form the energy of the successive unidirectional impulses supplied by the polyphase currents and then utilizing said stored potential energy in the form of a second set of unidirectional auxiliary impulses of currents, sent to fill (in the circuit which must be fed with continuous current) the gaps between the successive primary impulses proceeding directly from the original polyphase currents.

The method above described may be carried out in practice in a great variety of ways, a few of which are herein disclosed by way of example and explained with reference to the annexed drawings, which refer more particularly to the case of the transformation of three-phase currents.

In the accompanying drawings:

Figure 1 shows a converter for changing three-phase currents into unidirectional in-

termittent currents, said converter comprising a rotary mercury jet interrupter.

Fig. 2 shows an equalizer which by means of an inductance and a rectifier, fills up the gaps between the successive impulses of the intermittent current.

Fig. 3 is a diagrammatic view showing another form of converter and another form of equalizer, these being shown connected together as in use.

Fig. 4 shows the converter shown in Fig. 3, but slightly modified.

The apparatus for transforming alternating currents into practically constant direct currents comprises a converter A and an equalizer B. The converter, which is shown in Fig. 1, comprises a hermetically sealed vessel A^2 in which there is an atmosphere either of hydrogen, of illuminating gas, or of ether vapor. Mounted within the vessel A^2 which is cylindrical in form, are a plurality of electric contacts a, b, c, d, e and f at equally spaced distances. The contacts a to f inclusive are divided, so far as the operation is concerned, into two sets, one set a, b, c being connected together and to the apparatus or net-work k which is to be fed by the continuous current produced, and the other set d, e, f being connected respectively to the terminals 1, 2 and 3 of the polyphase current to be converted and transformed.

In the vessel A^2 of the converter there is provided a rotatable double nozzle tube g which is mounted to rotate about the axis of the cylindrical vessel and through the two nozzles of which mercury is adapted to flow in a radial direction toward the contacts a to f , so as to electrically connect, at intervals during the rotation of the nozzle, the contacts of one set with the diametrically opposite contacts of the other set. The arrangement is such that during the rotation of the mercury tube g the mercury jet impinges successively against the contacts d, e, f in the same order in which the highest positive potential is reached at every third of the period of the alternating current in the alternating current net-work, so that current of the highest positive potential will pass successively from the contacts d, e, f of the alternating side of the converter to the con-

tacts *a*, *b*, *c*, of the continuous current side thereof through the jet of mercury. Since the current is taken from each phase line of three-phase net-work during only one-third of the period and that third being the one in which the potential is highest, the continuous current or receiving side of the converter will successively receive impulses of current from the contacts *d*, *e*, *f*, which will be in only one direction but which will be intermittent, as will be well understood.

The tube *g* for the mercury jet is rotated by means of a synchronous motor which completes one-half turn at each period of the alternations of the current, this motor being fed from the alternating current which it is desired to transform. Suitable means for causing the motor and the mercury to rotate in proper synchronism may be provided.

The duration of a connection of the mercury jet with the contacts *d*, *e*, *f*, may also be varied so as to lengthen or shorten the duration of the successive impulses. This may be carried out by forming the contacts so that they taper, for instance triangular or trapezoidal form as shown in Fig. 5, and then providing for simultaneous adjustment of the contact transversely of the jet.

The continuous current net-work or apparatus *k* is connected on one side, as above stated, to the contacts *a*, *b*, *c*, by the wire *h* and on the other side it is connected to a neutral *N* in the alternating current net-work. If the latter net-work does not have a neutral, an artificial neutral may be provided by means of three-phase iron core and star-connection winding.

It will be noted that the mercury jet in its function in this system is quite different from its ordinary function which is merely to provide for a quick make and break. In the present case its function is to act as a connection between two sets of contacts at intervals which are substantially constant in duration.

As is above stated, the impulses given to the direct current net-work *k* by the mercury jet and the contacts *a*, *b*, *c*, and *d*, *e*, *f*, follow each other successively, but there are gaps between these impulses which must be filled if a substantially continuous current is to be produced. These gaps are filled according to the present invention by supplementary impulses generated and supplied to the direct current net-work by an equalizer *B* shown in Fig. 2. The equalizer comprises an inductance *o* and a current rectifier which may be in the form of an electrolytic cell *V*, having an aluminum plate *A*¹ and a lead plate *P*² immersed in solution of phosphate of sodium, phosphate of ammonium, or the like. The inductance *o* is arranged in series with the direct current net-work indicated by *k* in Fig. 2, while the rectifier *V* is shunt-

ed across the inductance and the direct current net-work. In other words, the rectifier *V*, the inductance *o* and the direct current net-work *k*, are arranged in series with each other forming a closed circuit.

The rectifier *V* is so arranged as to normally prevent the passage of current in parallel with the direct current net-work *k*, but to permit passage of the current and in fact to facilitate or boost it by means of its own energy and the condensation charge existing in the electrode of aluminum, when the flow of current ceases between the intervals of the impulses caused by the converter. The function of the rectifier is to render complete the circuit outside the converter when it is momentarily interrupted to make possible the utilization of the stored energy.

The function of the inductance is to supply energy for maintaining the current during the intervals of commutation of the converter, deriving such energy from the electromagnetic field which it has generated and which slightly diminishes during the brief pauses between two successive impulses.

The foregoing arrangements may be conveniently modified in order to secure several improvements and simplifications. Fig. 3 shows the converter *A*¹ and the equalizer *B*¹ both adapted for use with three-phase current.

As shown in Fig. 3, of the six contacts of the mercury jet interrupter, the contacts *a*, *b*, *c*, are omitted leaving only the three *d*¹, *e*¹, *f*¹ spaced at intervals of 120° and connected with the three terminals 1, 2, 3, of the three-phase line. The receiving net-work *k*, to which leads the conductor *h*, is, as in the other form, connected to the neutral point *N*, at one end; but, at the other end, instead of being attached to the three plates *a*, *b*, *c*, of the interrupter above described, is connected with the interrupter casing *p* and thereby to the mercury of the jet which impinges upon said casing at one side while impinging upon one of the contacts *e*¹, *d*¹, *f*¹ at the other side. In this way the periodic connection at every third of the period, between the phase lines and the neutral, through the receiving net-work, is established by one or the other of the two jets *g*¹ and *g*² diametrically opposed, which alternately and successively impinge upon the three contacts. Hence, these may be separated by a much greater space so as to prevent the jet from forming a short circuit between two adjacent plates.

In order to further maintain a greater steadiness in the intensity of the current circulating in the receiving net-work, a few turns *o*¹ of the wire through which flows the intermittent current, are wound on the iron core *o*² on which is wound the inductance *o*, as indicated in Fig. 3, immediately

before said wire joins the branches that go to the valve V and to the inductance σ . The purpose of these turns σ^1 of wire is that of rendering available, not only part of the intrinsic energy of the current which circulates in the winding σ but also the mutual energy $M.i.i_1$ of the winding σ and of the turns of wire σ^1 now added, in the circuit of the receiving net-work k , Fig. 3, during the pauses or decrements, M being the coefficient of mutual induction and i_1 the intermittent current (which arrives from the interrupter) at the moment the circuit is broken. The receiver may thus be fed during the pauses without the current i , which flows through the same, undergoing any perceptible diminution, and thus better securing the desired steadiness.

It should be understood that the rotary converter may be utilized, alone to produce an intermittent unidirectional current for any use, and likewise the equalizer may be utilized for rendering continuous, either pulsating or constant, any intermittent unidirectional current proceeding from any apparatus, even different from the converter above specified and illustrated in the drawing.

The type of rotary converter or interrupter shown in Fig. 3 in which a periodic closure of the circuit is made between a contact and the wall of the vessel has the advantage that by giving the contacts d' , e' , f' an angular width less than but close to 60° , the duration of the interval between the moment one of the jets leaves one of the contacts and the moment the diametrically opposite jet impinges upon the succeeding plate may be reduced at pleasure, even to the vanishing point.

The most suitable width of the plates must be determined experimentally, because experience has shown that the duration of the physical contact is slightly superior to that which might be inferred from the value of the angular width of the contacts, and that it is dependent also upon the nature of the gas filling the vessel. The final regulation may be made at the factory, or it may be effected on the apparatus by giving a trapezoid or triangular form to the contacts and adjusting them more or less, whereby the width of the plate traversed by the jet varies in extent.

In proportion as the duration of the pauses is being reduced, the action of the valve V, (lead-aluminum), in the equalizer is modified, said valve being designed, as explained, to make constant the pulsating and periodically interrupted tension.

In fact the aluminum anode acts as a condenser of great capacity; and an ordinary condenser of equivalent capacity may be substituted for it.

When the pause is reduced to zero, or the

overlapping in the periods of contacts, of two contacts with the jet is very brief, the action of the cells becomes practically unnecessary, and they may even be dispensed with. In order to render constant the current in the receiver, the inductance suffices in such case through its well-known properties, since in such case the current between the jet and the plates never falls. Arcs at break are not formed within the vessel, except those very weak ones due to the self-induction of the line wire which goes to the plate, and which can eventually be eliminated by arranging some small condensers γ between each contact and the casing. Hence the vessel need not be filled with inert gas, as illuminating gas, and the apparatus can be made to work open, while containing common air.

When the jet's separation from the plate is accompanied by a small arc at break, the plates may be covered externally (Fig. 5), with an insulating cover q , for instance, of porcelain, which viewed from the axis, projects beyond the plate over all its periphery for some little distance (Fig. 5). The short projection of porcelain, becoming covered with mercury, prolongs the plate metallically and the break is accomplished between mercury and mercury instead of between mercury and plate, that is, it preserves the latter from wearing away.

The vessel's wall may be lined inside with a cylindrical covering of hard and insulating material, for instance of enameled porcelain, whether adhering to the cylinder or independent of it.

Claims:

1. A system for transforming alternating current into constant continuous current, comprising a converter of the mercury jet type for transforming the alternating current into unidirectional current; means for connecting said converter with a source of alternating current; means for conducting the converted current from the converter for utilization; and an equalizer for delivering current between the successive impulses of the intermittent unidirectional current.

2. In a system for transforming polyphase alternating current into constant continuous current, a converter comprising an hermetically closed receptacle containing an inert gas, a rotating mercury jet in said receptacle, said jet throwing mercury in opposite directions, and contact plates arranged at uniform angular intervals inside said receptacle; means for connecting said plates with a source of alternating current; means for conducting the converted current from the converter for utilization; and an equalizer for supplying current between the successive impulses of the intermittent unidirectional current.

3. A system for transforming polyphase

alternating current into constant continuous current, as specified in claim 2, in which the contact plates have their outer sides and edges covered by an insulating material.

- 5 4. A system for transforming polyphase alternating current into constant continuous current, as specified in claim 2, in which the equalizer comprises an inductance and a receiving apparatus connected in series in
10 the unidirectional current circuit, and a valve, in parallel with said inductance and receiver, to open the local circuit when the inductance supplies current between the main impulses of the unidirectional current,
15 and to close said local circuit when the main impulses are received.

5. A system for transforming polyphase alternating current into constant continuous current, as specified in claim 2 in which the
20 equalizer comprises an inductance and a valve, each on respectively parallel branches of the conductor for the converted current, said inductance constituted by a winding of its branch on an iron core and an auxiliary
25 winding over said first winding and consisting of a few turns of the conductor for the converted current in its part preceding the branching point.

6. A system for transforming three-phase alternating current into constant continuous
30 current, as specified in claim 2, in which the converter comprises an hermetically closed receptacle, the body of which is conductive and forms part of the circuit, three contact
35 plates at angular intervals of 120° connected to a source of three-phase current, a conductor connecting said body with a current receiver, and a double mercury jet, revolving
40 once every two periods and alternately and successively connecting one of the plates to the mercury in the receptacle and thence to the body.

7. A system for transforming polyphase alternating current into constant continuous
45 current, as specified in claim 2, in which the plates are substantially trapezoidal in shape so as to vary the length of contact with the mercury.

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

Rome, this 27th day of November, 1917.

ORSO MARIO CORBINO.

Witnesses:

LETTANO CHABOCETTA,
AUGUSTO EGGENSCHWILER.