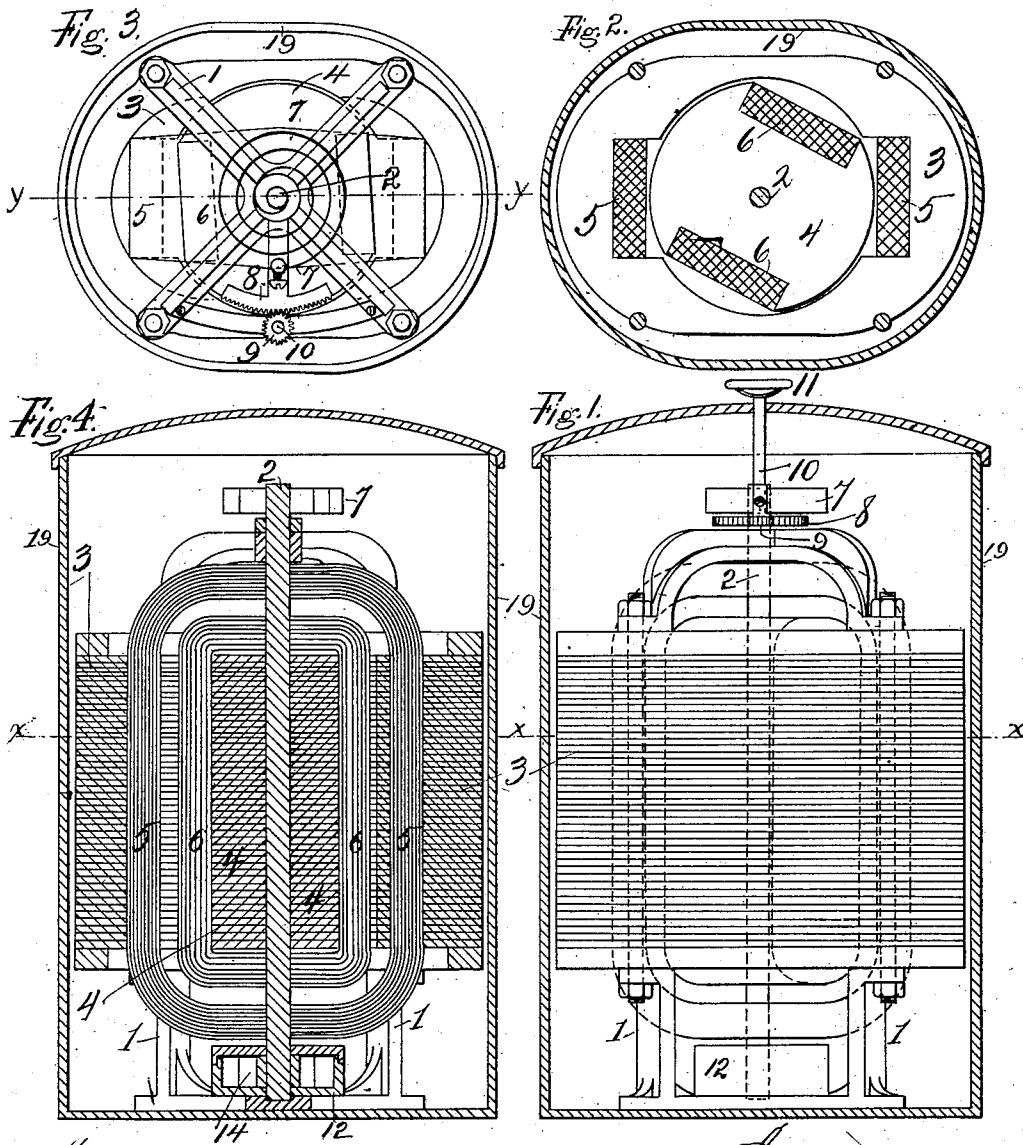


D. O. HULL.
CONSTANT CURRENT TRANSFORMER.

APPLICATION FILED JAN. 15, 1902.

NO MODEL.

2 SHEETS—SHEET 1.



Witness:
Arthur J. Brown
L. E. Brown.

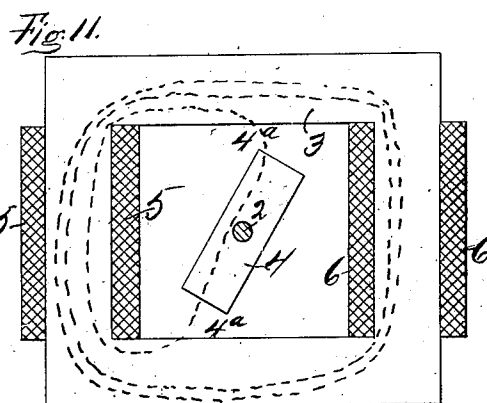
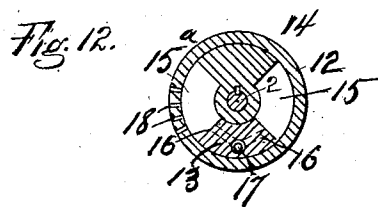
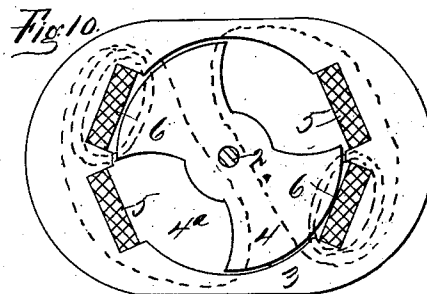
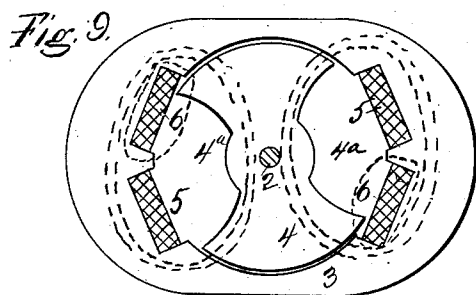
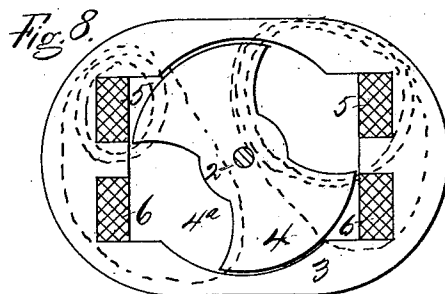
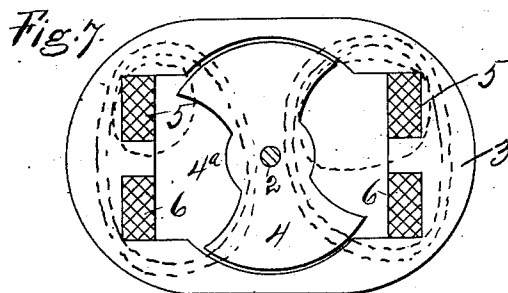
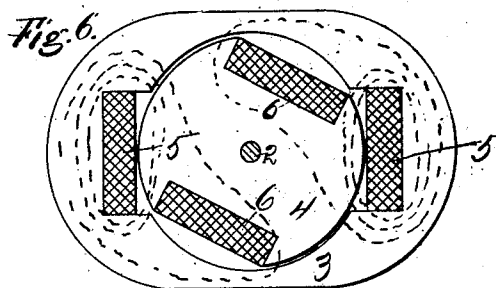
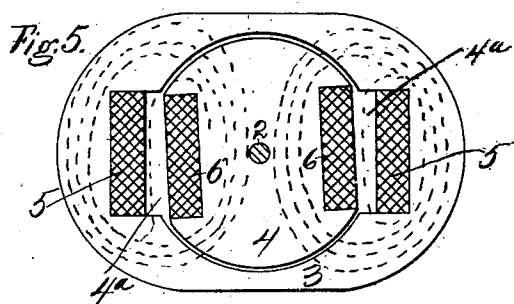
Inventor:
Daniel O. Hull,
By his Atty.
J. M. Hall.

D. O. HULL.
CONSTANT CURRENT TRANSFORMER.

APPLICATION FILED JAN. 15, 1902.

NO MODEL.

2 SHEETS—SHEET 2.



Witness:
R. E. Brown
L. E. Brown

Inventor:
By his atty. David O. Hull
Hiram Hull.

UNITED STATES PATENT OFFICE.

DANIEL OSCAR HULL, OF ST. LOUIS, MISSOURI.

CONSTANT-CURRENT TRANSFORMER.

SPECIFICATION forming part of Letters Patent No. 735,103, dated August 4, 1903.

Application filed January 15, 1902. Serial No. 89,797. (No model.)

To all whom it may concern:

Be it known that I, DANIEL OSCAR HULL, a citizen of the United States, residing at St. Louis, in the State of Missouri, have invented certain new and useful Improvements in Constant-Current Transformers; and I do 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, and to the figures of reference marked thereon, which form a part of this specification.

My invention relates to and its object is to provide a cheap and simple means for automatically maintaining constant a current of electricity derived or transformed from a constant-potential alternating current, and more particularly to accomplish this purpose by means of a device which is adapted to automatically shunt the magnetic flux of a primary coil around (*i. e.*, in exclusion of) the secondary coil through a path of low reluctance; to vary the reluctance of this path by the swing or rotation of an iron core in the presence of the two coils; to provide facilities in the transformer for adjusting the strength of the derived current, and to secure and maintain a relatively high power-factor at all loads. I attain these results by means of the devices and arrangement of parts hereinafter described, and shown and illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of my transformer, showing the case of the same in central vertical section; Fig. 2, a top plan view of my transformer, taken on line *x x*, Fig. 1; Fig. 3, a top plan view of the same with the cover removed; Fig. 4, a central vertical sectional elevation of my device, taken on line *y y*, Fig. 3; Fig. 5, a central transverse plan view of my device with the case removed; Fig. 6, the same, showing the central movable core and the secondary coil in position to shunt the greater part of the magnetic flux of the primary coil around the secondary coil. Fig. 7 is a like view of a modified form of my device, showing the position of the movable core when the derived circuit is at full load; Fig. 8, the same, showing the movable core in position to shunt the magnetic flux around the secondary coil; Figs. 9 and 10, like views

of another modified form of my device, showing the movable core in normal position and in shunt position; Fig. 11, another modified form of my device, showing the central movable core in position to shunt part of the magnetic flux around the secondary coil, and Fig. 12 is a transverse sectional plan view of the damping device or dash-pot hereinafter referred to.

Like numerals of reference indicate like parts throughout the drawings.

In the drawings, 1 is a frame, in which is journaled a shaft 2. The frame supports a stationary core 3, of laminated soft iron, and the shaft supports a like core 4, the latter core being disposed in an opening through the former core and being adapted to swing on its shaft. In the various modifications of my invention herein illustrated, except that shown in Fig. 11, the inner movable core 4 has its two ends enlarged and formed in an arc of the circle described by the end pieces when swung on shaft 2. These enlarged end portions swing near to the inner walls of the outer core, which are also curved in the arc of a circle. In Figs. 1 to 6, inclusive, I have shown the outer core provided with a coil 5, which is wound in the opposite sides of the opening through the outer core. This coil is suitably connected and in circuit with a source of constant-potential alternating electricity. In the form of my device illustrated in Figs. 1 to 6, inclusive, the inner core 4 carries a coil 6, wound in the recesses formed by the pole extensions of the inner core. This secondary coil 6 is electrically connected and is arranged to be thrown into circuit with a series of arc-lamps or other suitable resistance. The electrical connections for the primary and secondary coils here referred to are not shown in the drawings, but will be understood without further illustration.

7 is a coiled spring, one end of which is secured to the shaft 2, the other end being secured to a toothed sector 8. This sector engages and is actuated by a pinion 9, the shaft of which, 10, extends through the top of the case and is provided with a hand-wheel 11, by means of which the pinion and toothed sector may be actuated and the tension of the spring 7 adjusted. The tension of this spring will determine the magnetic attrac-

tions within the transformer necessary to swing the core 4 on its bearings to any given point. To prevent the momentum of the core 4 carrying it too far and to avoid sudden fluctuations, which make the current unsteady, a damping device is employed. (See Figs. 4 and 12.) It consists of a circular case 12, containing a stationary sector 13 and a movable sector 14, secured to the bottom of the shaft 2. The spaces 15 and 15^a within the case between the two sectors are filled with oil and are in communication with each other through the holes 16 and the check-valve 17 in the first sector. As the shaft 2 and its sector rotate to the right the space 15 decreases and space 15^a increases in capacity. The oil in the former space is forced through the holes 16 and check-valve 17 into the latter space, and the oil flows more or less freely as the opening in the check-valve is more or less restricted, thus damping and retarding the movement of the shaft 2 and the core 4. When the shaft rotates to the left, the oil in space 15^a escapes freely through the holes 18 in the wall of the case, it being desired to retard the movement of the shaft in but one direction.

The parts hereinbefore referred to are inclosed in a case 19, which for the sake of insulation and for cooling purposes is filled with oil.

The operation of my device thus far described is as follows: The primary coil 5, receiving a constant alternating current from some source of supply, induces an alternating magnetic flux in the cores 3 4 and when the circuit is closed through the secondary coil induces therein an electromotive force which may be utilized in a series of arc-lamps or the like. The alternating magnetic flux induced by the primary coil produces in the primary coil a reactive electromotive force opposing the impressed electromotive force, the value of the reactive electromotive force depending upon the number of magnetic lines of force threading the primary coil. The current induced in the secondary coil flows in a direction opposite to that in the primary coil, and hence induces a magnetic flux opposing that induced by the primary coil, thus increasing the reluctance of the magnetic circuit in the inner part of the core 4 in proportion to the increase of current in the secondary coil. When the current in the secondary coil tends to increase, thus increasing the reluctance of the path through the core 4, part of the lines of force following the path of lowest resistance will flow across the air-gap 4^a, as illustrated by the dotted lines in Fig. 5, attracting the rotating inner core and bringing it into the position shown in Fig. 6, shortening the air-gap and shunting more of the magnetic flux around the secondary coil. The deflection of the inner core is assisted by the repelling action which obtains when two parallel coils carry currents in opposite directions. The extent

of the deflection of the inner core will increase as the derived current increases, shunting more of the magnetic flux around the secondary coil, thus decreasing the electromotive force induced in the secondary coil and tending to reduce the derived current to its normal value. As the air-gap is decreased the flux threading the primary coil increases, (see dotted lines, Fig. 6,) increasing the reactive electromotive force and decreasing the primary current in relation to the electromotive force of the derived circuit, whereby a relatively high power-factor is maintained at all loads.

The deflection of the inner core is resisted by the tension of the spring 7. The farther the core is pulled around the greater will be the tension of the spring and at the same time the greater will be the attraction to be resisted. The tension of the spring must be such that it balances exactly the attraction of the core at different positions when the secondary current is kept constant.

In Figs. 7 and 8 I have shown the outer core carrying both the primary and secondary coils. In this form of construction the primary and secondary coils are parallel. The dotted lines indicate the flux. Fig. 8 shows the core shunting the flux around the secondary coil, thus lessening the electromotive force of the derived circuit and producing a self-regulation of the action of the device, as above described.

Figs. 9 and 10 show the outer core carrying both the primary and secondary coils; but in this modification of my device it should be understood that the coils cross at top and at bottom of the core. Fig. 9 shows the normal position of the movable core at full load, and Fig. 10 shows the inner movable core deflected and the flux shunted around the secondary coil, with the result above stated.

In Fig. 11 I have shown the rotary core formed in rectangular cross-section and the primary and secondary coils wound on separate legs of the outer core. The operation of this modification of my device will from the above description be now fully understood without further explanation.

From the foregoing description and discussion of my invention other and further modifications of my devices will suggest themselves to those skilled in the art, and I do not, therefore, limit myself to the details of construction here illustrated and described.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a constant-current transformer, a primary coil, a secondary coil, a two-part core for said coils, one of said parts being revolvably journaled and adapted and arranged, by its movement, to shunt the magnetic flux of the primary coil through the core around said secondary coil in harmony with the variations of current in the latter coil.

2. In a constant-current transformer, a pri-

mary coil, a secondary coil, a revoluble core part of iron adapted and arranged by its movement to shunt the magnetic flux of the primary coil around the secondary coil, which core part moves in harmony with the variations of current in the secondary coil, the arrangement of the coils and core part being such that the reluctance of the magnetic circuit is automatically varied in harmony with the movement of said core part.

3. In a constant-current transformer, a primary coil, a secondary coil, a two-part core for said coils, one of said parts being pivotally supported centrally within and independently of the other part, the arrangement of said coils and said core parts in relation to each other being such that said pivoted core part swings on its pivotal support in harmony with the variations of current in the secondary coil and such that the magnetic flux of the primary coil is threaded around the secondary coil in harmony with the movement of said pivoted core.

4. In a constant-current transformer, a primary coil, a secondary coil, a two-part core for said coils, one of said parts being centrally pivoted within the other part, adapted by change of their relative positions to shunt the magnetic flux of the primary coil through said cores around the secondary coil, a spring adapted to hold said two parts in predetermined normal relation to each other, and means for adjusting the tension of said spring.

5. In a constant-current transformer, a primary coil, a secondary coil, two core parts for said coils one of said parts being stationary, the other part being centrally pivotally and independently mounted in the stationary part and adapted, by its movement, to shunt the magnetic flux of the primary coil through the core parts around the secondary coil, and a damping device which retards the too-quick movement of said latter core part.

6. In a constant-current transformer, a primary coil and a secondary coil, a laminated

iron core, having an opening therethrough, another core journaled in said opening and adapted to rotate in the plane of the former core, and pole extensions on said latter core in juxtaposition with the inner walls of said opening the arrangement being such that the movement of the inner core and its pole extensions shunts the magnetic flux of the primary coil around the secondary coil.

7. A constant-current transformer comprising a primary coil, a secondary coil, a two-part core for said coils, bearings for one of said core parts midway between its ends and upon which said part moves within the other part, a spring adapted to govern the position of said movable part, means for adjusting the tension of said spring, and a damping device for retarding the movement of said movable core part the arrangement of the cores and coils being such that the movement of one of said cores is in harmony with the fluctuations of the secondary circuit and such that the magnetic flux of the primary coil is shunted around the secondary coil in harmony with the variations of current in the secondary coil.

8. In a constant-current transformer, a primary coil, a secondary coil, a movable core of iron which forms part of the magnetic circuit and which by its movement increases the reluctance of said magnetic circuit in harmony with the decrease of the current in the secondary coil and which decreases the reluctance of said magnetic circuit in harmony with the increase of current in the secondary coil, said movable core being centrally pivoted and having its opposite extremities symmetrically disposed relatively to said two coils.

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

DANIEL OSCAR HULL.

Witnesses:

H. W. ORCUTT,
EDWARD A. PEASE.