No. 792,196. PATENTED JUNE 13, 1905.

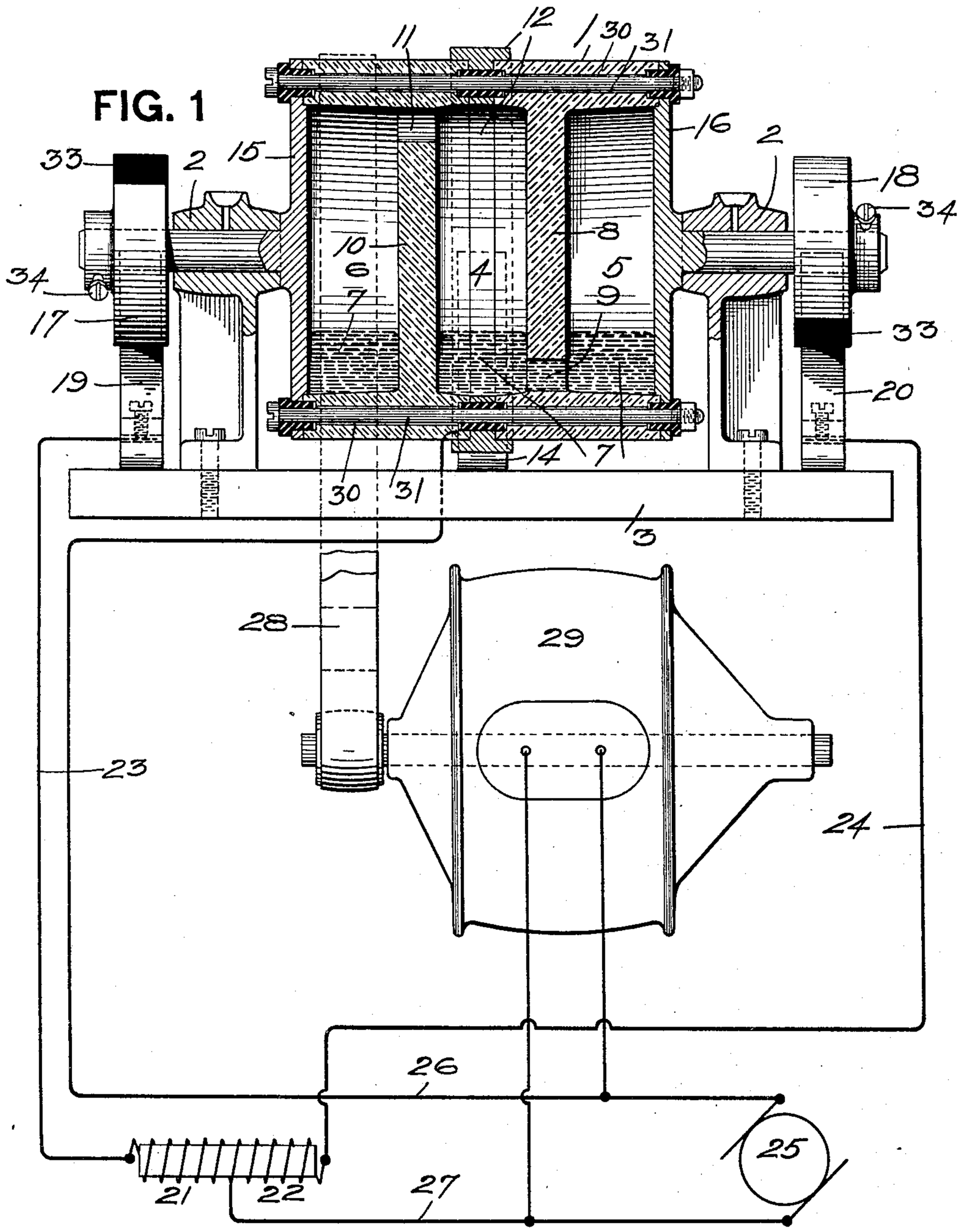
A. F. CHRISTMAS.

# ROTARY MERCURY CIRCUIT BREAKER.

APPLICATION FILED SEPT. 23, 1904.

2 SHEETS—SHEET 1.

FIG. 1




WITNESSES.

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2 SHEETS—SHEET 2.

FIG. 2

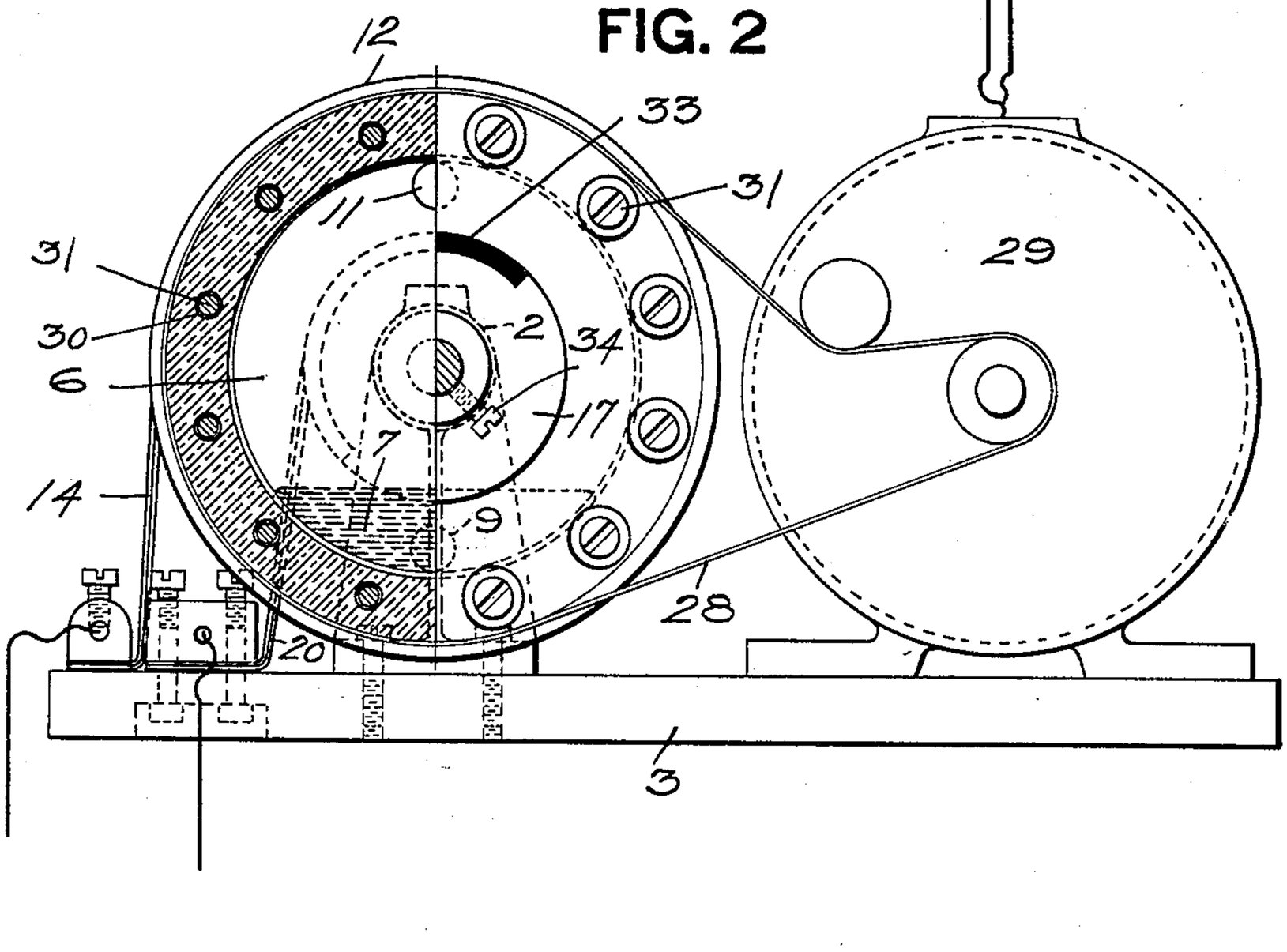
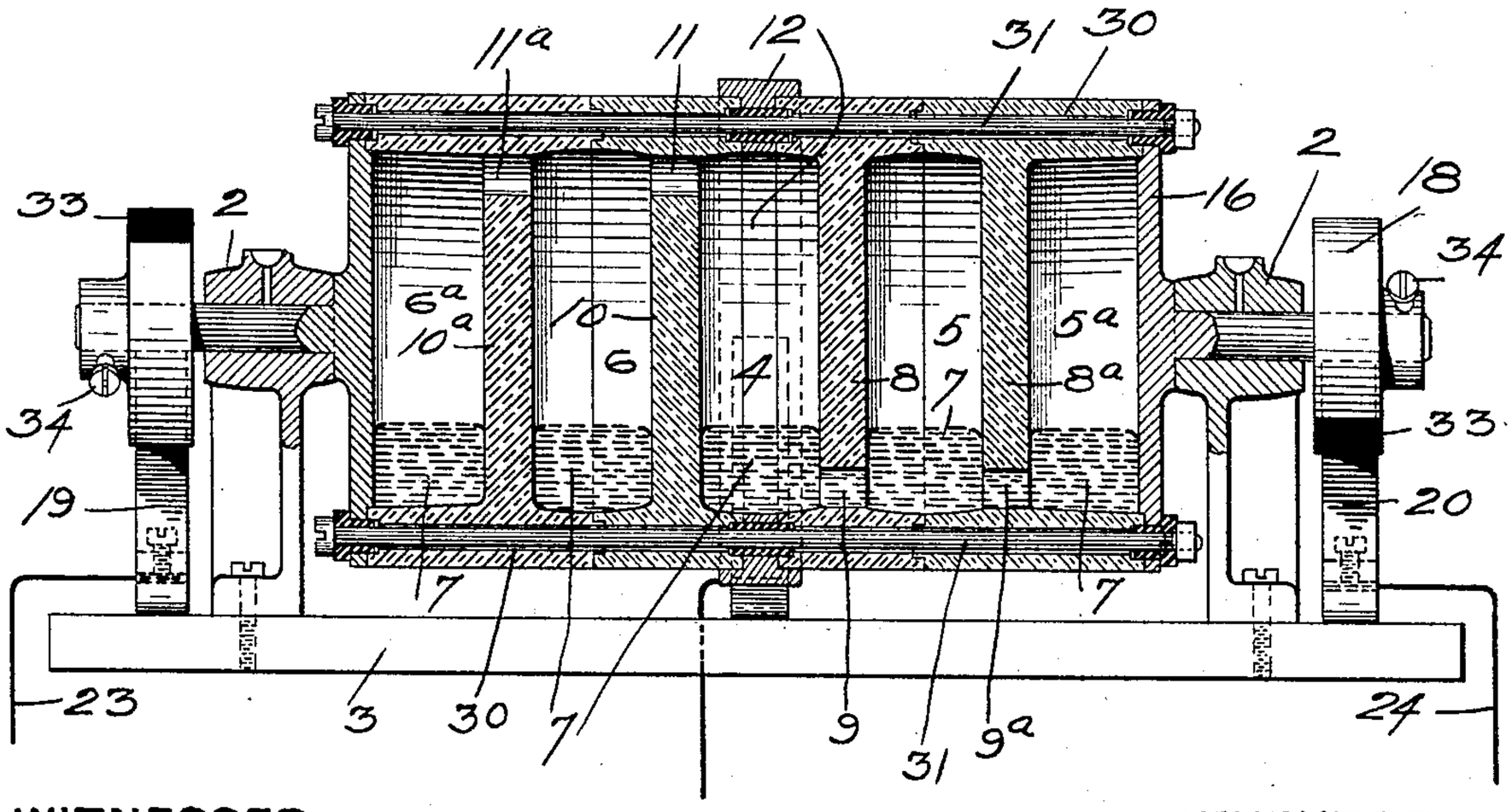



FIG. 3

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# UNITED STATES PATENT OFFICE.

ADOLPH F. CHRISTMAS, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR OF TWO-THIRDS TO FRANK R. McFEATTERS, OF WILKINSBURG, PENNSYLVANIA.

## ROTARY MERCURY CIRCUIT-BREAKER.

SPECIFICATION forming part of Letters Patent No. 792,196, dated June 13, 1905.

Application filed September 23, 1904. Serial No. 225,684.

*To all whom it may concern:*

Be it known that I, ADOLPH F. CHRISTMAS, a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Rotary Mercury Circuit-Breakers; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to circuit-interrupters whereby commercial currents can be continuously broken and again made.

The object of my invention is to so construct the circuit-breaker that the evil effects which result from the arcs which are formed when the circuit is broken are overcome.

Specifically my invention relates to devices of this character whereby the current is continuously broken and again made and alternately connected to two different translating devices or two different windings of the same translating device.

A further object of the invention is to provide a circuit-interrupter of the character specified whereby the moment of energization of the coils of the translating device relative to the moment of deënergization thereof can be regulated so as to vary the duration of the energization of said coils and, if desired, secure a longer and stronger pull in one coil than in the other and also to vary the time of energization of the two coils, so as to get the same into exact synchronism with a reciprocating core or plunger coöperating with said coils.

With many translating devices—such, for instance, as reciprocating motors and the like provided with a plurality of coils—it is either necessary or desirable to break and make the circuit at rapid intervals and to direct the current alternately through two coils of the motor or to two independent translating devices. One difficulty in doing this is that the arcs which are formed when an ordinary commercial current is interrupted detrimentally affect the terminals of the circuit-interrupter, thus soon destroying the same and making the interrupter useless. This difficulty has prevented the commercial use of translating devices which depend upon rapid interruptions of the current for their operation.

One object of my invention is to provide a circuit-interrupter for these purposes wherein the above defect is overcome.

To this end the invention consists, generally stated, in breaking the circuit between mercury terminals inclosed in practically-sealed chambers, so that the arcs which are formed will expend themselves in volatilizing the mercury; but as the latter is contained in a closed chamber it will immediately condense and again join the main body of mercury.

With reciprocating motors having two coils for operating the core or plunger it is desirable that the coil for giving the forward or working stroke to the core be energized more strongly than the coil giving the return stroke thereto. It is also desirable that the coil for giving the working stroke be energized at the exact moment that the plunger or core has completed its return stroke, so as to be in exact synchronism with the vibration of said core.

Another object of my invention is to provide a circuit-interrupter having adjusting means for regulating the time when the circuit through the coil giving the working stroke is made, so that this time can be varied in order that the coil may be energized at the exact moment when the core has reached the limit of its return stroke; also, in providing adjustable means for regulating the duration of the energization of the two coils, so that, if desired, the coil giving the working stroke may be given a stronger energization than the coil giving the return stroke.

The invention also comprises certain details of construction hereinafter described and claimed.

In the accompanying drawings, Figure 1 is a longitudinal section through one form of my circuit-interrupter, showing in diagram the circuits to which the same is connected. Fig. 2 is in part a transverse section through the same and in part an end view of the same, and Fig. 3 is a longitudinal section showing the same modified so as to break the circuit at several points in series with each other.

Preferably my circuit-interrupter will be of the rotary type and has been so shown. It comprises a suitable movable body 1, which may be oscillated or rocked, and is shown as rotatably mounted in bearings or standards 2, secured to an insulating-base 3. The body is provided with two or more chambers insulated from each other.

The interrupter shown in Figs. 1 and 2 is designed to direct the current alternately through two translating devices or two coils of the same translating device. In this interrupter the body is provided with three chambers 4, 5, and 6, which are insulated one from the other, as may be done by forming the walls or partitions of some insulating substance, such as porcelain, glass, fiber, or the like. In each of these chambers is a body of mercury 7, which bodies, however, only partially fill the said chambers. The partition 8 between the chambers 4 and 5 is provided with an opening 9 therethrough, and the partition 10 between the chambers 4 and 6 is likewise provided with an opening 11 therethrough. When the body has been moved or rotated so that either of the openings comes below the surface of the mercury, the mercury in the two chambers will flow into contact through said opening, thus establishing the electric circuit. The two openings 9 and 11 are arranged preferably oppositely, or substantially so, so that the circuit from the chamber 4 will be made alternately to the chambers 5 and 6. In the chamber 4 there is exposed an annular metallic terminal 12, which is formed as a metallic ring interposed between the two sections in which the body is formed. This ring has an exterior circular surface, against which bears a brush 14, connected to one terminal of the circuit. As a consequence there is a constant electrical connection to the mercury 6 in the chamber 4. In the chambers 5 and 6 likewise will be exposed metallic terminals, with which the mercury will be in contact, these terminals preferably being circular or annular, so that the mercury in said chambers will be in constant contact with said terminals. As shown in the drawings, these terminals are formed by metallic heads 15 and 16, respectively, forming the ends of the chambers and provided with the trunnions whereon the body is rotatably mounted in the bearings 2. On the ends of these trunnions are current-collecting rings 17 and 18, respectively, against which bear brushes 19 and 20, which are connected to the separate translating devices or to different coils of the same translating device and which in turn are connected to the other pole of the circuit. The translating device or devices are shown in the diagram as comprising two coils 21 and 22, the former of which is connected by a conductor 23 to the brush 19 of the circuit-interrupter and the latter of which is connected by a conductor 24 to the brush 20 of the circuit-interrupter. The generator is shown at 25, and one main 26 leads from the same to the brush 14, which is in permanent electrical connection with the mercury in the chamber 4, while the return-main 27 from the coils 21 and 22 is connected centrally thereto and to the other brush of the generator. This circuit-interrupter may be rotated in any desirable way—such, for instance, as by means of a crank connected to one of the trunnions of the body—but preferably by means of a belt 28 passing around the body thereof and coming from any suitable source of power, such as the counter-shaft in a factory or other suitable source. When used in an electrical system, however, it is convenient to rotate the interrupter from a motor bridged across the circuit, and in Fig. 1 is shown a diagram illustrating a motor 29 as bridged across the mains and having its armature-shaft connected by means of the belt 28 with the body of the interrupter. In the rotation of the body the mercury remains in the bottoms of the several chambers, and it will flow into contact through the openings 9 and 11, respectively, when said openings are moved to the lower side of the body. It will be obvious that when one of these openings dips below the surface of the mercury the circuit will be established through the same, said circuit coming from the brush 14, metallic ring 12, thence through the mercury in the chamber 4, and through the opening in the partition to the mercury of one of the end chambers, and out through the metallic end wall of said chamber to the outgoing brush 19 or 20, as the case may be. Inasmuch as the openings 9 and 11 are oppositely arranged the current will be made alternately through the coils 21 and 22 of the translating device. As soon as the body has been rotated sufficiently far to bring the opening above the surface of the mercury the latter will flow out of the same, thus breaking the circuit. An arc will necessarily be formed; but this will merely expend itself in vaporizing a portion of the mercury; but as the latter is contained in a practically sealed chamber it will again condense and join the main body of the mercury. It will be obvious that the rapidity of making and breaking the circuit will depend upon the rapidity of rotating the body. If desired, more than a single opening may be made through each of the partitions 8 and 10, thus getting a more rapid interruption of the current or permitting a slower rotation of the interrupter.

In Fig. 3 is shown a modified form of interrupter adapted for use with heavy currents, which when broken will form a long arc. In this case I provide for the breaking of the current at several points in series with each other, as described and claimed in my application filed August 15, 1904, Serial No. 220,823. In this modification on each side of the chamber 4 are provided two or more chambers,

two being shown, 5 and $5^a$ and 6 and $6^a$, respectively. The partition $8^a$ between the chambers 5 and $5^a$ is provided with an opening $9^a$ in line with the opening 9 in the partition 8, and the partition $10^a$ between chambers 6 and $6^a$ is likewise provided with an opening $11^a$, which is in line with the opening 11 in the partition 10. Each of the five chambers contains mercury, and it will be obvious that when the circuit is broken with this modification it will be interrupted at two points in series with each other—for instance, at the points 9 and $9^a$ or 11 and $11^a$. This, as is well known, will divide the voltage by the number of interruptions in series, and the length of the arc will be correspondingly reduced. This principle may be extended so as to provide on each side of the central chamber any number of chambers greater than shown, so as to reduce the voltage at each break to such a degree that even very heavy commercial currents can be safely broken.

If it is desired not to direct the current alternately through two different translating devices, but merely to make and break the same, the interrupter will comprise only two chambers, one connected to one terminal of the circuit and the other connected to the other terminal of the circuit, and the partition between the said chambers will be provided with an opening or openings through which the mercury will flow into contact to establish the circuit. Such modification is intended to be included in the terms of the claims hereinafter made.

When the coils 21 and 22 are parts of a motor which has a reciprocating core or plunger, it is desirable that the coil giving the forward or working stroke should be energized the moment that the core has reached the limit of its return stroke. If the holes 9 and 11 through the partitions 8 and 10, respectively, of Fig. 1 are arranged exactly diametrically opposite each other, it may happen that the energization of the coil will not take place until a moment after the plunger has made its full stroke. I provide means for adjusting these holes relatively to each other, so as to insure the energization of the coil giving the working stroke at the exact moment that the plunger reaches the limit of its return stroke. The two sections of the body are shown as provided with a series of holes 30, through which pass securing-bolts 31. In Fig. 2 twelve such openings and bolts are shown. It is obvious that if the bolts 31 be removed the two body-sections can be rotated relatively to each other through one-twelfth of their circumference and the bolts can again be passed through the holes to hold the body-sections together. In this manner the holes 9 and 11 may be adjusted relatively in steps of thirty degrees. By increasing the number of holes 30 an angular adjustment of less than thirty degrees may be secured. This adjustment can be so arranged as to insure the making of the circuit through the coil giving the working stroke at the exact moment that the plunger reaches the limit of its return stroke, so as to have the energization in exact synchronism with the oscillation of the core. It may also be desirable that the coil giving the working stroke should be more strongly energized than the coil giving the return stroke. This I accomplish by making the collector-rings 17 and 18 so that they will also act as circuit-makers. To this end said collector-rings have set into their surfaces segmental portions of insulating material 33, against which the brushes 19 and 20 bear. These segmental portions 33 are shown as extending half-way around the collector-rings; but this may of course be varied. The collector-rings are secured to their respective arbors, so that they can be angularly adjusted thereon, a suitable means for this purpose being set-screws 34, adapted to be screwed down tightly against the arbors. In this manner the angular position of the collector-rings can be changed at will. The length of time that the circuit remains closed at the mercury contacts depends upon the height of the mercury in the chambers and the speed of rotation. Should it be desired to shorten the duration of energization of either of the coils, the proper collector-ring will be angularly adjusted on its arbor, so that the metallic portion thereof will not come underneath the brush until, say, by way of illustration, the opening 9 or 11, as the case may be, has passed practically halfway through the mercury body. The circuit will be broken at the mercury as soon as the opening passes above the surface of the mercury, so that by this arrangement the coil will have been energized for only half of the time that the mercury was in contact through the opening 9 or 11. By adjusting the collector-rings to the desired angular position any desired duration of energization of the coils can be secured, and the coil giving the working stroke can be given a longer energization, and therefore a stronger and more powerful pull, whereas the coil giving the return stroke need have only a short and weak energization. The metallic portions of the collector-rings will be sufficiently long so that the circuit will never be broken at said collector-rings, but will always be broken between the mercury in the chambers of the interrupter, so as to neutralize the evil effects of the arcs.

With all forms of my interrupter the holes or openings through the partitions between the several chambers are of only small section in the arcuate path of said holes, and they can be located so as to dip only slightly below the surface of the mercury. In this way the current will be maintained but a short time through each of the coils and the evil resulting from the heating of the coils due to maintaining the current for a longer period than necessary will be entirely overcome.

Many changes may be made in the details of construction and arrangement of the parts described without departing from the spirit of my invention.

What I claim is—

1. A circuit-interrupter comprising a movable body provided with two or more chambers insulated from each other, a body of mercury in each of said chambers but only partially filling the same, and circuit-terminals exposed in at least two of said chambers, the wall or partition between said chambers being provided with an opening or openings through which the mercury in the two chambers will come into contact and establish the circuit when the body is moved.

2. A circuit-interrupter comprising a movable body provided with two or more chambers insulated from each other, a mobile conducting medium in each of said chambers but only partially filling the same, and circuit-terminals exposed in at least two of said chambers, the wall or partition between said chambers being provided with an opening or openings through which the conducting medium in the chambers will come into contact and establish the circuit when the body is moved.

3. A circuit-interrupter comprising a rotatable body provided with two or more chambers insulated from each other, a mobile conducting medium in each of said chambers but only partially filling the same, and circuit-terminals exposed in at least two of said chambers, the wall or partition between said chambers being provided with an opening or openings through which the conducting medium in the chambers will come into contact at intervals in the rotation of the body.

4. A circuit-interrupter comprising a rotatable body provided with two or more chambers insulated from each other, a body of mercury in each of said chambers but only partially filling the same, and annular conducting-faces exposed in at least two of said chambers, the wall or partition between said chambers being provided with an opening or openings through which the mercury in the two chambers will come into contact at intervals in the rotation of the body.

5. A circuit-interrupter comprising a rotatable body provided with two or more chambers, a body of mercury in each of said chambers but only partially filling the same, terminals exposed in at least two of said chambers, and a wall or partition of insulating material between said chambers and provided with an opening or openings through which the mercury in the chambers will come into contact at intervals in the rotation of the body.

6. A circuit-interrupter comprising a movable body provided with two or more closed chambers insulated from each other, a body of mercury in each of said chambers but only partially filling the same, and circuit-terminals exposed in at least two of said chambers, the wall or partition between said chambers being provided with an opening or openings through which the mercury in the two chambers will come into contact and establish the circuit when the body is moved.

7. A circuit-interrupter comprising a rotatable body provided with two or more chambers insulated from each other, a mobile conducting medium in each of said chambers, and circuit-terminals exposed in at least two of said chambers, the wall or partition between said chambers being provided with an opening or openings of small section in the arc in which the same travels, and through which the conducting medium in the two chambers will come into contact for a short period of time at intervals in the rotation of the body.

8. A circuit-interrupter comprising a movable body having three or more chambers insulated from each other, a mobile conducting medium in each of said chambers but only partially filling the same, constant electrical connections to the conducting medium in the middle chamber, and electrical connections to the conducting media in the two end chambers, the walls or partitions between the middle and end chambers being provided with openings arranged out of line, whereby when the body is moved the conducting media in the two end chambers will come alternately into contact through said openings with the conducting medium in the central chamber and thereby establish the circuit.

9. A circuit-interrupter comprising a movable body having three or more chambers insulated from each other, a body of mercury in each chamber but only partially filling the same, constant electrical connections to the mercury in the middle chamber, and electrical connections to the mercury in the two end chambers, the walls or partitions between the central chamber and the two side chambers being provided with openings arranged out of line with each other, whereby when the body is moved the mercury in the two end chambers will come alternately into contact through said openings with the mercury in the central chamber and thereby establish the circuit.

10. A circuit-interrupter comprising a movable body having three or more chambers insulated from each other, a mobile conducting medium in each chamber but only partially filling the same, constant electrical connections to the conducting medium in the middle chamber, and electrical connections to the conducting media in the two end chambers, the walls or partitions between the middle and end chambers being provided with openings arranged out of line with each other, whereby when the body is moved the conducting media in the two end chambers will come alternately into contact through said openings with the conducting medium in the central chamber and thereby establish the circuit.

11. A circuit-interrupter comprising a rota-

table body having three or more chambers insulated from each other, a mobile conducting medium in each chamber but only partially filling the same, an annular conducting-surface exposed in the central and the two end chambers, and electrical connections to said conducting-faces, the walls or partitions between the central and two side chambers being provided with openings arranged out of line with each other, whereby when the body is rotated the conducting media in the two end chambers will come alternately into contact through said openings with the conducting medium in the central chamber and thereby establish the circuit.

12. A circuit-interrupter comprising a rotatable body having three or more chambers, a body of mercury in each chamber but only partially filling the same, constant electrical connections to the mercury in the central and end chambers, and walls or partitions of insulating material between the central and two end chambers, said walls or partitions being provided with openings arranged substantially opposite to each other, whereby when the body is rotated the mercury in the two end chambers will come alternately into contact through said openings with the mercury in the central chamber.

13. A circuit-interrupter comprising a movable body having a plurality of chambers insulated from each other, a body of mercury in each of said chambers but only partially filling the same, electrical connections to the bodies of mercury in the two end chambers, the partitions between the several chambers being provided with openings in line with each other, whereby when the body is moved the mercury in the several chambers will come into contact through said openings and establish the circuit at two or more points in series with each other.

14. A circuit-interrupter comprising a rotatable body provided with two end chambers, electrical connections to both of said end chambers, a number of chambers intermediate said end chambers and insulated therefrom, a body of mercury in each of the several chambers, insulating-walls separating the said chambers and provided with openings or holes in line with each other, whereby in the rotation of the body the mercury will come in contact through said openings to make and break the circuit at said several points in series with each other.

15. A circuit-interrupter comprising a rotatable body provided with a chamber, a body of mercury in said chamber but only partially filling the same, constant electrical connections to said mercury, and two terminals arranged to be alternately electrically connected to the mercury at intervals in the rotation of the body and being angularly adjustable relatively to one another.

16. A circuit-interrupter comprising a rotatable body having three or more chambers insulated from each other, a body of mobile conducting medium in each chamber but only partially filling the same, electrical connections to the conducting media in the said several chambers, insulating walls or partitions separating said bodies and provided with an opening or openings, whereby when the body is rotated the conducting medium in the two end chambers will come alternately into contact through said openings with the conducting medium in the central chamber, and means for adjusting said partitions angularly with reference to each other to vary the relative positions of the holes therethrough.

17. A circuit-interrupter comprising a rotatable body, partitions therein dividing the same into three or more chambers, a body of mobile conducting medium in each chamber but only partially filling the same, electrical connections to the conducting medium in each chamber, the partitions between said chambers being provided with an opening or openings through which the conducting medium will flow into contact, said body and partitions being provided with a series of holes, and securing-bolts passing therethrough and being removable, whereby the angular relations of the holes in the partitions may be varied.

18. A circuit-interrupter comprising a rotatable body provided with a chamber, a pair of circuit-terminals exposed in said chamber one at least of which is of mercury, constant electrical connections to one of said terminals, a collector-ring rotatable with the body and connected to the other terminal, said collector-ring having a conducting-surface extending only partially around the same, means for adjusting said collector-ring angularly with reference to the body, and a brush bearing against said collector-ring.

19. A circuit-interrupter comprising a rotatable body provided with a chamber, a body of mercury in said chamber but only partially filling the same, a circuit-terminal connected to said mercury, a pair of oppositely-arranged terminals arranged to come alternately into contact with said mercury, collector-rings secured to rotate with the body and connected to said two oppositely-arranged terminals, said collector-rings being provided with conducting-surfaces extending only partially around the same, means for adjusting said collector-rings angularly with reference to the body, and brushes bearing against said collector-rings.

20. A circuit-interrupter comprising a rotatable body having a plurality of chambers insulated from each other, a body of mercury in each chamber but only partially filling the same, the wall or partition between the said chambers being provided with an opening or

openings to permit the mercury to come into contact to establish the circuit, a circuit-terminal in permanent connection with one of said bodies of mercury, a terminal exposed to the other body of mercury, a collector-ring connected to said last-named terminal and mounted to rotate with the body, said collector-ring being provided with a conducting-surface extending only partially around the same, means for adjusting said collector-ring angularly with reference to the body, and a brush bearing against said collector-ring.

21. A circuit-interrupter comprising a rotatable body having three or more chambers insulated from each other, a body of mercury in each chamber but only partially filling the same, the walls or partitions between said chambers being provided with oppositely-arranged openings to permit the mercury to come into contact and establish the circuit, a circuit-terminal in permanent electrical connection with the mercury of the middle chamber, terminals in contact with the mercury in the two side chambers, collector-rings connected to each of said terminals and mounted to rotate with the body, said collector-rings being provided with conducting-surfaces extending only partially around the same, means for adjusting said collector-rings angularly with relation to the body, and brushes bearing against said collector-rings.

22. A circuit-interrupter comprising a rotatable body having three or more chambers insulated from each other, a body of mercury in each of said chambers but only partially filling the same, the walls or partitions between said bodies being provided with an opening or openings to permit the mercury to come into contact and being angularly adjustable with relation to each other, a circuit-terminal in permanent electrical connection with the mercury in the middle chamber, terminals in contact with the mercury in each of the side chambers, a collector-ring connected to each of said terminals and mounted to rotate with the body, said collector-rings being provided with conducting-surfaces extending only partially around the same, means for adjusting said collector-rings angularly with reference to the body, and a brush bearing against each of said collector-rings.

In testimony whereof I, the said ADOLPH F. CHRISTMAS, have hereunto set my hand.

ADOLPH F. CHRISTMAS.

Witnesses:
ROBERT C. TOTTEN,
G. C. RAYMOND.