F. CEDERGREN.

SINUSOIDAL WAVE CURRENT APPARATUS.

APPLICATION FILED OCT. 7, 1907.

979,060.

Patented Dec. 20, 1910.

2 SHEETS—SHEET 1.

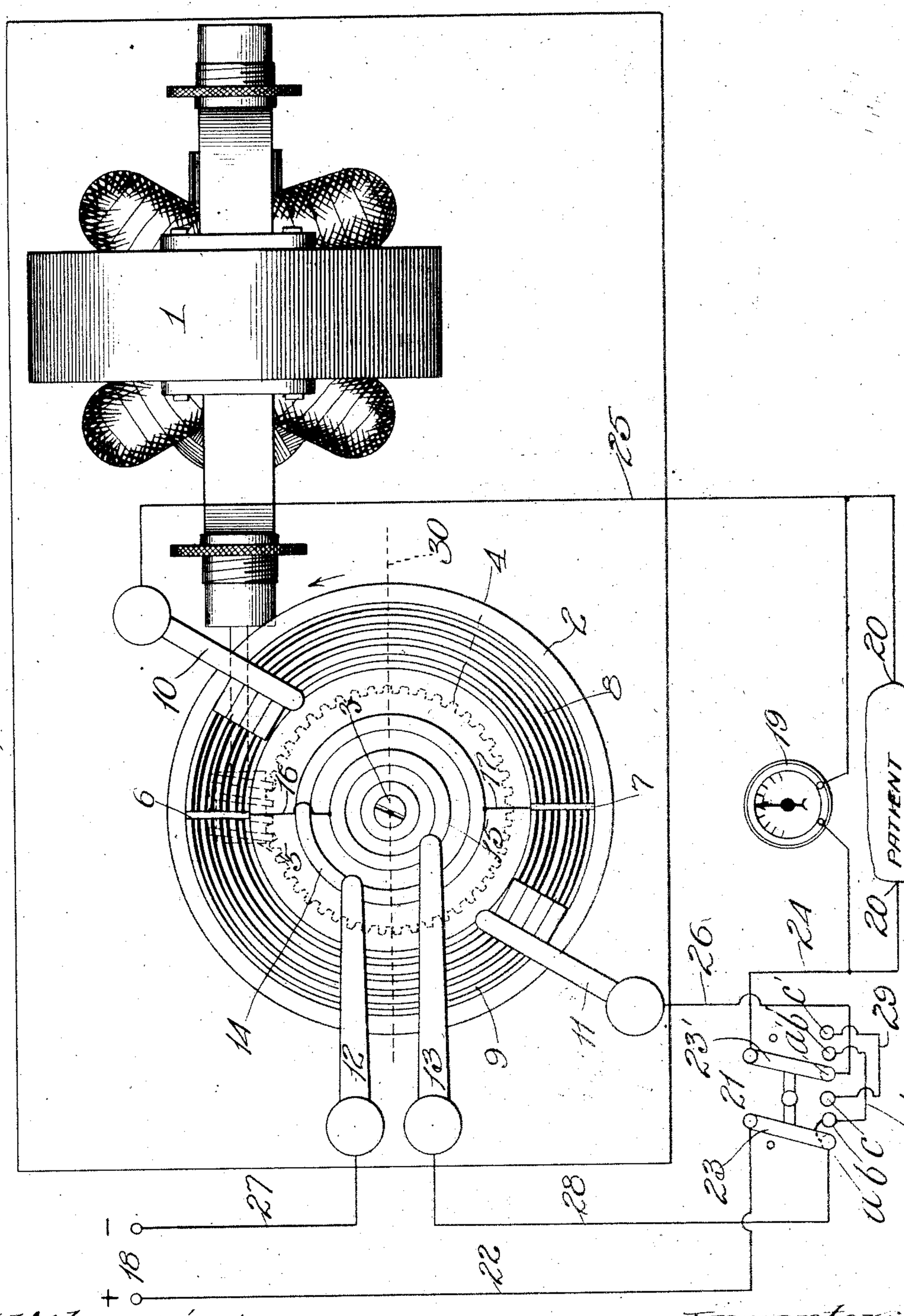


Fig. 1.

Witnesses

Harry P. L. White

Ray White.

Inventor:

Fred Cedergren

By Rummler & Rummler

Attys.

F. CEDERGREN.

SINUSOIDAL WAVE CURRENT APPARATUS.

APPLICATION FILED OCT. 7, 1907.

979,060.

Patented Dec. 20, 1910.

2 SHEETS—SHEET 2.

Fig. 2.

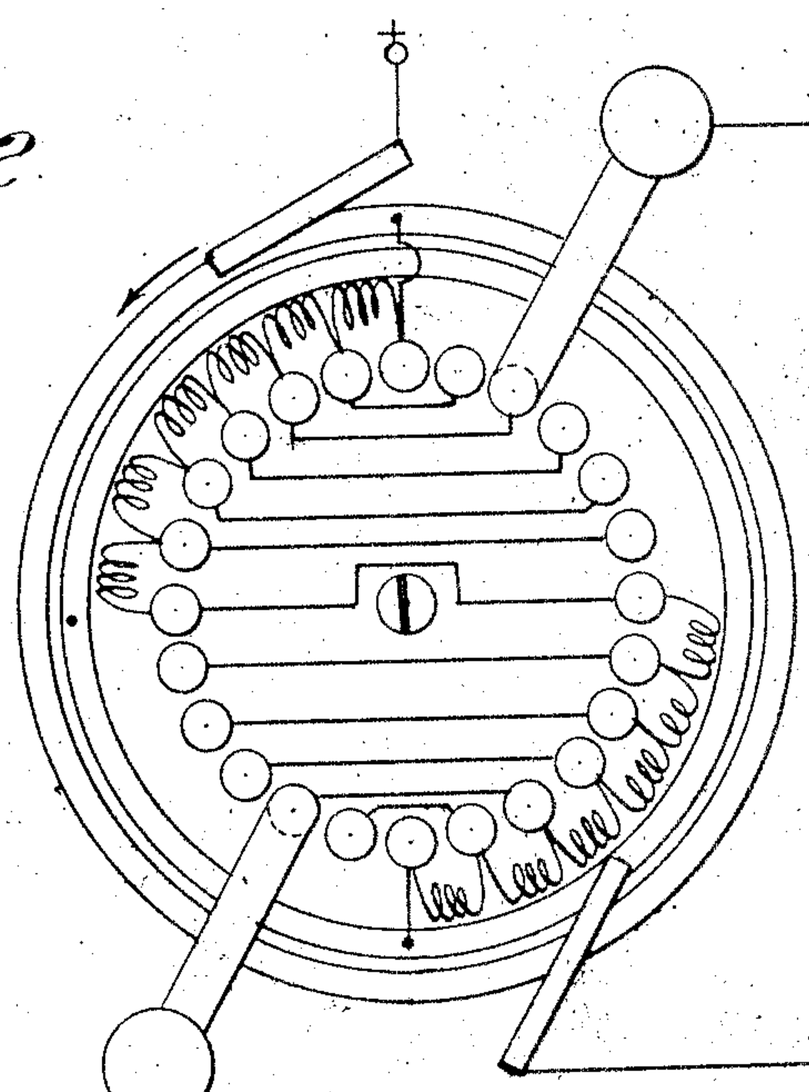


Fig. 4.

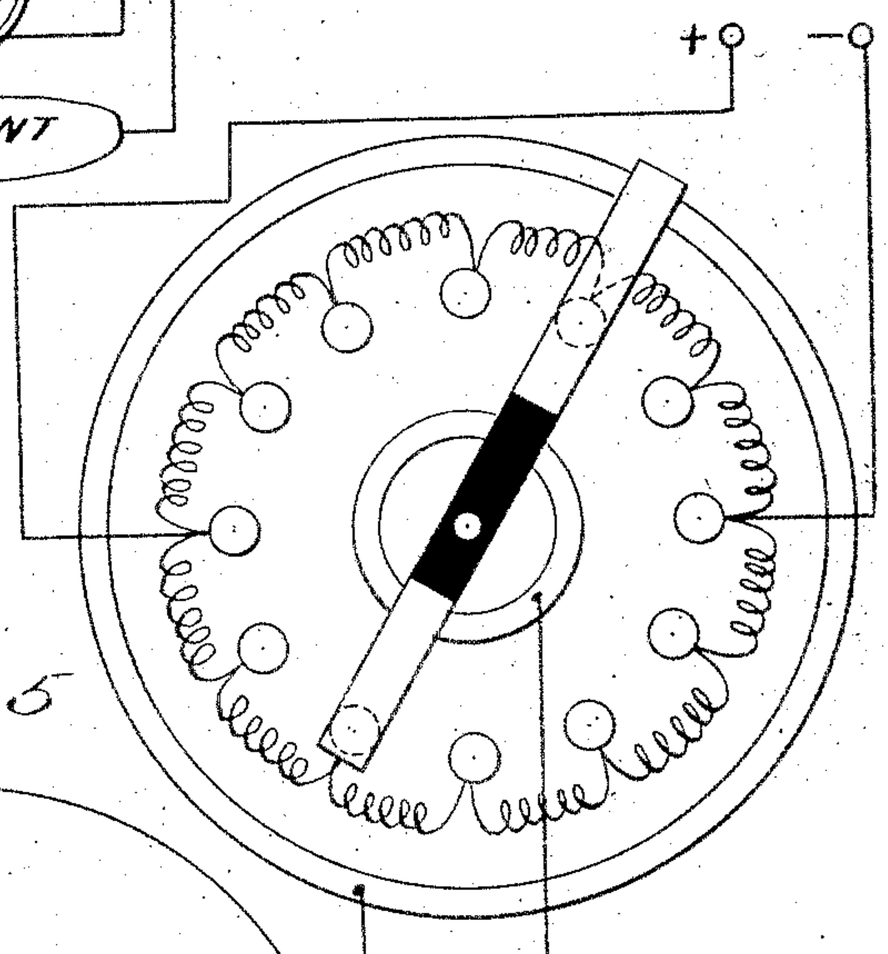


Fig. 3

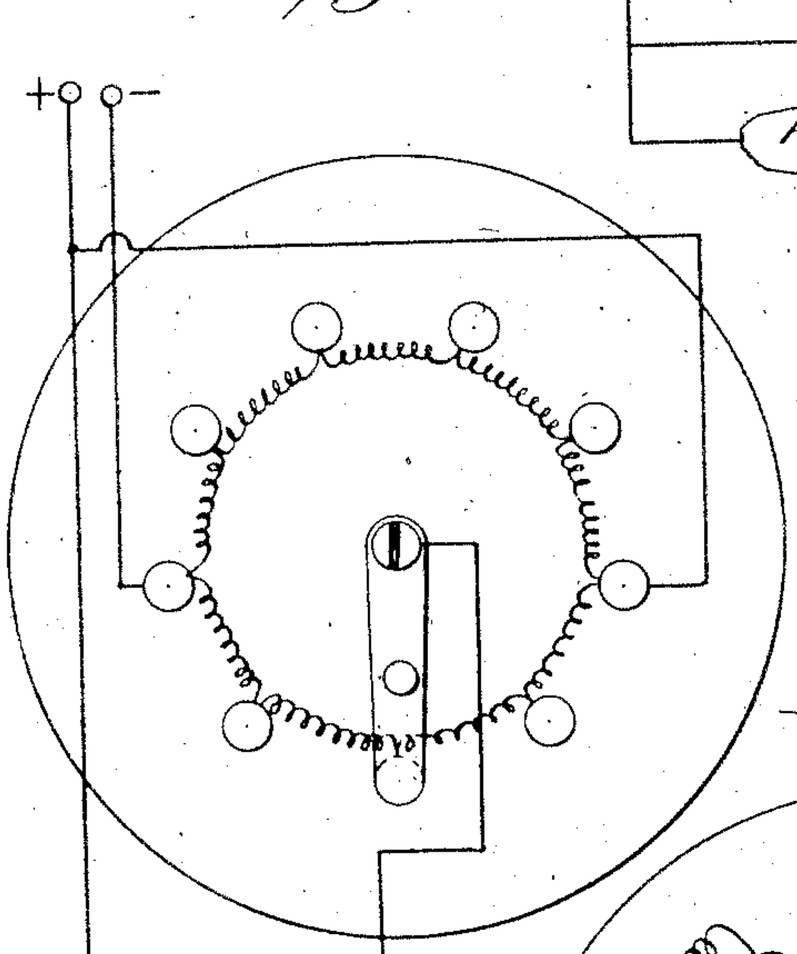
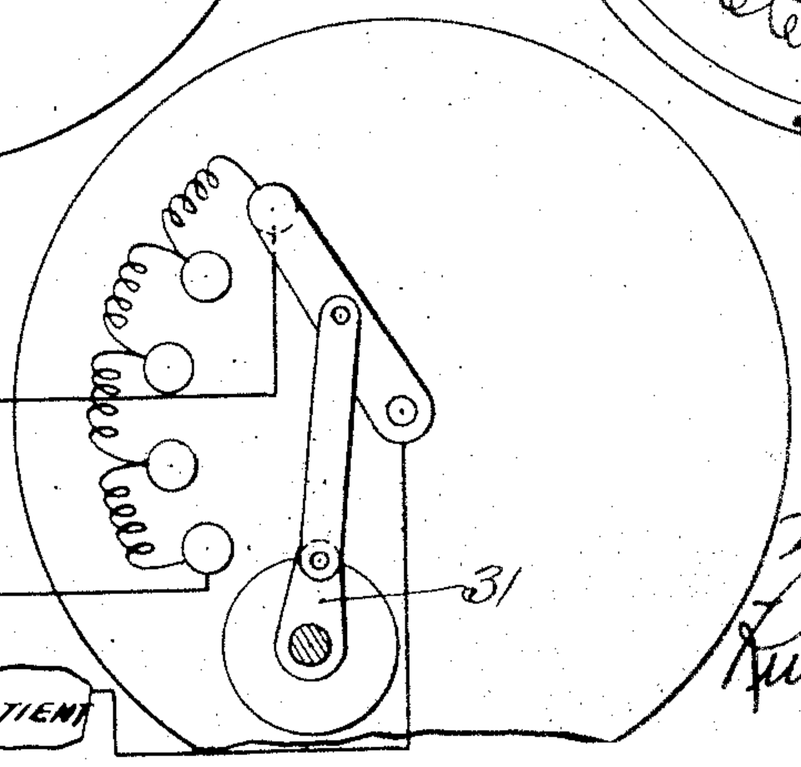


Fig. 5



Witnesses

Harry R. L. White

Harry White

Inventor:

Fred Cedergren,

Kummler & Kummler,

Attys.

UNITED STATES PATENT OFFICE.

FRED GEDERGREN, OF HAMMOND, INDIANA, ASSIGNOR OF ONE-HALF TO FRANK S. BETZ, OF HAMMOND, INDIANA.

SINUSOIDAL-WAVE-CURRENT APPARATUS.

979,060. Specification of Letters Patent. **Patented Dec. 20, 1910.**

Application filed October 7, 1907. Serial No. 396,261.

To all whom it may concern:

Be it known that I, FRED CEDERGREN, a citizen of the United States of America, and a resident of Hammond, Lake county, Indiana, have invented certain new and useful Improvements in Sinusoidal-Wave-Current Apparatus, of which the following is a specification.

The main objects of this invention are to provide an improved form of electro-therapeutic device adapted to produce sinusoidal wave currents of electricity of such nature that they may be passed through the human body without shock, for the purpose of producing alternating relaxations and contractions of the muscles, for the purpose of developing them or curing diseases, the effect being somewhat in the nature of that of massage; to provide an apparatus of this class which is capable of producing sinusoidal currents, either constant or alternating in direction, in which the voltage gradually increases and decreases without break or sudden change; and to provide an improved method of connecting the various parts of an apparatus of this character, whereby the character of the changes in the current may be controlled at the will of the operator. These objects are accomplished by the device shown in the accompanying drawings, in which—

Figure 1 is a schematic plan, partly diagrammatic, of an electro-therapeutic apparatus constructed according to this invention. Fig. 2 is a diagrammatic view illustrating a modified form of rheostat with metal contacts and resistance arranged in small steps so as to be suitable for the purpose of this invention. Figs. 3, 4 and 5 are further modifications of the rheostat.

In the form shown in Fig. 1, the apparatus comprises a motor 1 and a rheostat of special construction, with a source of current and a circuit provided with electrodes for application to the human body. The rheostat comprises a disk 2 of slate or other suitable non-conducting material mounted to rotate about its axis 3, and arranged to be continuously driven by means of the worm-wheel 4 and the worm 5 on the motor shaft.

The disk 2 is provided with variable resistance, preferably in the form of a continuous annular band or strip of conducting material, this strip being formed of alternate segments of relatively high and relatively low resistance, arranged symmetrically, similar segments being in pairs diametrically opposed. In the form shown, two short metal segments 6 and 7 are separated by long segments 8 and 9 formed of graphite uniformly distributed upon the surface of the disk 2 between the segments 6 and 7, the segments 8 and 9 being of uniform width throughout their length, and the entire strip having a smooth, unbroken top surface. The brushes 10 and 11 bear upon this rheostat strip, and a second pair of brushes 12 and 13 bear upon the annular conductors 14 and 15 which are respectively connected by conductors 16 and 17 with the metal segments 6 and 7. The brushes 10, 11, 12, and 13 constitute the rheostat terminals. These conductors and brushes are connected in the manner which will be hereinafter described with a suitable source of electric current at 18, a meter 19, patient's electrodes 20, and a controlling switch 21. This switch is provided with double switch arms respectively contacting with contact segments a b c and a' b' c'. The switch contacts a and b are electrically connected, and so are the contacts b b' and also the contacts c c'. The positive lead of the line from the source of electricity 18 is connected by the conductor 22 to the switch arm 23. The other switch arm 23′ is connected by the conductor 24 with the meter 19 and one of the patient's electrodes 20, the electrodes 20 and the meter 19 being parallel with each other. The brush 10 is connected by the conductor 25 with the meter and the other patient's electrode. For the purpose of distinguishing from the main line conductors, the conductors 24 and 25 will be herein termed "service conductors."

The brush 11, which bears upon the rheostat strip at a point diametrically opposite the brush 10, is connected by the conductor 26 with the switch contact a'. The brush 12 is connected with the negative lead of the line by the conductor 27, and the brush 13 is connected with the switch contacts a, b and b' by the conductors 28 and 28′. The conductor 29 connects the switch contacts c and c'.

The operation of the device shown in Fig. 1 is as follows:—The rheostat segments 6 and 7 preferably extend across the entire

radial width of the graphite strips, so that the current passing through the strip of graphite will tend to spread out across the entire width thereof, and thus avoid local stress upon the graphite at the point of entrance or departure of the current. Assume that the circuit is receiving current from the source 18, and that the switch is in the position shown in Fig. 1, and that the motor is being continuously driven so as to cause the disk 2 to rotate continuously in one direction. The segments 6 and 7 will in this case have the full potential of the line, and the resistance sections 8 and 9 will act as potential distributers between segments 6 and 7, and equal angular displacement on either side of segments 6 or 7 will give substantially equal potential. When the brushes 10 and 11 are in contact with the segments 6 and 7, the potential between the brushes 10 and 11 will be full line potential. As the disk 2 revolves, the potential between the brushes will be reduced reaching zero when the line 30 is under the brushes, at which time the potential of both brushes will be one-half the line potential. The path of the current is then traced as follows:—from the positive lead of the line through 22, 23, *a*, 28, 13, 15, 16, 6, through a portion of the rheostat segment 8, brush 10, then through 25, to the meter and patient's electrodes, then through 24, 23′, *a*′, 26, brush 11, 7, 17, 12, and 27, to the negative lead of the line. It will be seen that the current flows through the rheostat in a divided path, one part flowing from the rheostat segment 6 to the brush 10, and there dividing, a part passing out into the brush 10, and another part following the graphite segment 8 to the rheostat contact 7. The second part of the current, which divides at the segment 6, flows through the segment 9 and combines with the flow of current between the brush 11 and the segment 7.

As the disk 2 continues to rotate,—say in a counter-clockwise direction, the brush 10 becomes gradually farther removed from the segment 6, and the resistance of the two paths of the current in the rheostat becomes equalized when the brushes 10 and 11 are midway between the segments 6 and 7. This position is indicated by the dotted diameter 30. At this time there is no E. M. F., and accordingly no current passing between the patient's electrodes. As soon as the disk 2 shifts so that the brushes are at the other side of the line 30, then the current in the patient's circuit will be reversed in sign, and, through the continued rotation of the disk, will gradually increase until it reaches full strength when the brushes are in contact with the metal segments 6 and 7. In this manner the rotation of the disk 2 causes in the patient's circuit an undulating current, which gradually changes from zero to maximum strength, and from maximum to zero, and so on, always reversing its direction in passing through zero.

With the switch in the position shown in Fig. 1,—that is, in contact with the switch contacts *a* and *a*′, there will be produced in the patient's circuit a sinusoidal or undulating alternating current, the changes in the flow of current being gradual and without any abrupt breaks. When the switch is shifted so that the switch arms are in engagement with the contacts *b* and *b*′, the patient's electrodes will be connected as a shunt of the line, but in such relation with the rheostat that the patient's circuit will bridge a variable amount of the resistance all of the time except during the instant when the brush 10 is in contact with the segment 6, the flow of current being then as follows:—from 18, through 22, 23, to *b*, there dividing, one part flowing through 28, 13, 15, 16, 6, there dividing and passing through the two graphite strips 8 and 9 to the segment 7. The second part of the current, which divided at *b*, flows through 28′ to *b*′, then through 23′, 24, patient's electrodes and meter, 25, to the brush 10, where it joins with the current passing between the segments 6 and 7. All of the current then flows through the conductors 17, 14, 12, and 27, to the negative line. In this second position of the switch 21, no current flows through the brush 11. When the brush 10 is in contact with the segment 7, almost all of the current will flow through the service conductors or patient's circuit, and but a very small part will flow through the graphite segments 8 and 9 on account of the relative resistances of the two paths. The continued rotation of the disk 2 carries the brush 10 gradually farther away from the metal segment 7, and therefore gradually decreases the flow of current in the patient's circuit, as the length of the part of the graphite segment 8 in circuit therewith increases, and it falls to zero when the brush 10 is on the segment 6. Continued rotation of the disk 2 now gradually reduces the resistance and increases the flow of current between the patient's electrodes, but without changing the direction of the flow, as was the case when the switch arms were in contact with the members *a* and *a*′. When the segment 7 arrives at the brush 10, the current will have again reached its maximum. In this instance the current is again of undulating character, and gradually passes from maximum strength to zero, and from zero to maximum strength, and so on through repeated cycles, without changing its sign.

When the switch arms are shifted to the switch contacts *c* and *c*′, the flow of the current is as follows:—from the source 18, through 22, 23, *c*, 29, *c*′, 23′, 24, then through

the meter and patient's circuit, then through conductor 25 to brush 10, then through the rheostat strip in a divided path to the segment 7, and finally through conductors 17, 14, 12, and 27, back to the source. In this case the brush 11 is again cut out of the circuit, as is also the brush 13, and the current in patient's circuit is at a certain minimum when the brush 10 is in contact with the segment 6. In this case all of the graphite is in series with the patient's electrodes, the current dividing at 6, and equal quantities flowing through both sides of the rheostat to the segment 7. As the disk 2 rotates, the brush 10 gradually approaches nearer to the segment 7, cutting out resistance in the patient's circuit, until the current therein reaches its maximum when the brush is in contact with the segment 7. In this case the undulations of the current in the patient's circuit are between a certain maximum and a certain minimum value, both of the same sign, and the changes are again gradual and without breaking the circuit at any time. For this position of the switch, the fluctuations in the patient's circuit are of lesser amplitude than in the other two cases, and the changes are more gradual.

When the switch arms 23 and 23′ are in contact with *a* and *a′*, as shown in Fig. 1, then the rheostat disk 2 is connected directly across the line 18, and the service electrodes 20, 20 are connected to the brushes 10 and 11. Under this condition the potential at the service electrodes will change from maximum to minimum in each quarter revolution of the rheostat disk, since the minimum potential will occur at the time when the line 30 is under the brushes 10 and 11, and the line 30 will pass the brushes twice per revolution.

When the switch arms are in contact with *b* and *b′*, the potential of the brush 10 connected to one service electrode will be at a maximum when the segment 7 is in contact with the brush 10, and at a minimum when the segment 6 is in contact with the brush 10, and the potential at the service electrodes will change from maximum to minimum in each half revolution of the disk. In a similar manner, when the switch arms 23 and 23′ are in contact with *c* and *c′* the current will be maximum when the segment 7 is in contact with the brush 10, which occurs once every full revolution, and the current will change from maximum to minimum in each half revolution.

In the modified forms which are shown in Figs. 2 to 5, inclusive, the graphite strips are replaced by a succession of insulated metal contacts connected with variable resistance somewhat in the nature of the ordinary rheostat, with the exception that the contacts are assumed to be close together and the resistance is so arranged and the contacts so connected that there will be no abrupt change or reversal of the current due to the rotation of the disk. In these cases also the current is not gradually undulating as in the form shown in Fig. 1, since the resistance is thrown in or out of the circuit in steps of considerable magnitude, instead of infinitesimal steps, as is the case with the graphite rheostat.

In the forms shown in Figs. 3, 4 and 5, the parts which correspond to the brushes 10 and 11 of Fig. 1 are carried by an arm which is mounted to rotate while the rheostat disk is stationary. In the form shown in Fig. 5, the rotation is oscillatory and is produced by the continuous rotation of the crank 31. The connections between the various conductors in Figs. 2 to 5, inclusive, need not be herein described, as they each correspond to individual conditions that may be had in the device shown in Fig. 1 by setting the switch in different positions.

What I claim as my invention and desire to secure by Letters Patent is:—

1. A device of the class described, comprising a disk having thereon an annular conductor comprising a strip of resistance material, a pair of brushes bearing on said strip at diametrically opposite points, an electric circuit comprising conductors in circuit with said brushes and having connection separate from said brushes with two diametrically opposite parts of said strip, means for rotating said disk and brushes relatively to each other about the axis of said strip, electrodes for connecting a patient in said circuit, and a switch comprised in said circuit and adapted at will to connect said electrodes either in shunt with a variable part of said strip part of the time, or in series with said strip most of the time.

2. A device of the class described, comprising a disk of insulating material having thereon a continuous annular strip of conducting material comprising alternate segments of relatively high and relatively low resistance arranged symmetrically in diametrically opposed pairs, a pair of brushes bearing on said strip at diametrically opposite points, an electric circuit comprising conductors, including electrodes, in circuit with said brushes and having connection with two diametrically opposed parts of said strip, means for rotating said disk and brushes relatively to each other about the axis of said strip, and switching means adapted to vary the connection between the various parts so as to produce at will currents having sinusoidal changes in voltage and either alternating in direction or flowing continuously in one direction when said disk and brushes are relatively rotated.

3. A device of the class described, comprising a rotatable member having thereon an annular strip of resistance material, a

pair of annular conductors insulated from each other and respectively connected to diametrically opposite points of said strip, brushes bearing on said conductors, a pair of fixed brushes bearing upon said resistance strip at diametrically opposite points, an electric circuit including a source of electricity and patient's electrodes, together with said brushes, means for continuously rotating said disk, and a switch controlling said circuit and adapted to connect the patient's electrodes either solely in series most of the time or in parallel part of the time with a variable part of the resistance strip on said member at the will of an operator, said connections being such that the relative movement of said member and the brushes bearing on said resistance strip will cause undulatory changes in the resistance in the patient's circuit for each position of said switch.

4. The combination of line conductors, service electrodes, rheostat terminals, switching means, a rheostat member rotatably mounted and adapted to vary the potential of one pair of terminals from maximum to minimum in one quarter revolution, and adapted through said switching means to vary the current from maximum to minimum in one half revolution, said rheostat terminals being connected between said line conductors and said service electrodes, and means for maintaining a substantially uniform relative rotation of said rheostat member.

Signed at Chicago this 3rd day of October 1907.

FRED CEDERGREN.

Witnesses:
E. A. RUMMLER,
MARY M. DILLMAN.