No. 862,361. PATENTED AUG. 6, 1907.

W. H. THOMPSON.

ELECTRICAL APPARATUS.

APPLICATION FILED JULY 17, 1905.

2 SHEETS—SHEET 1.

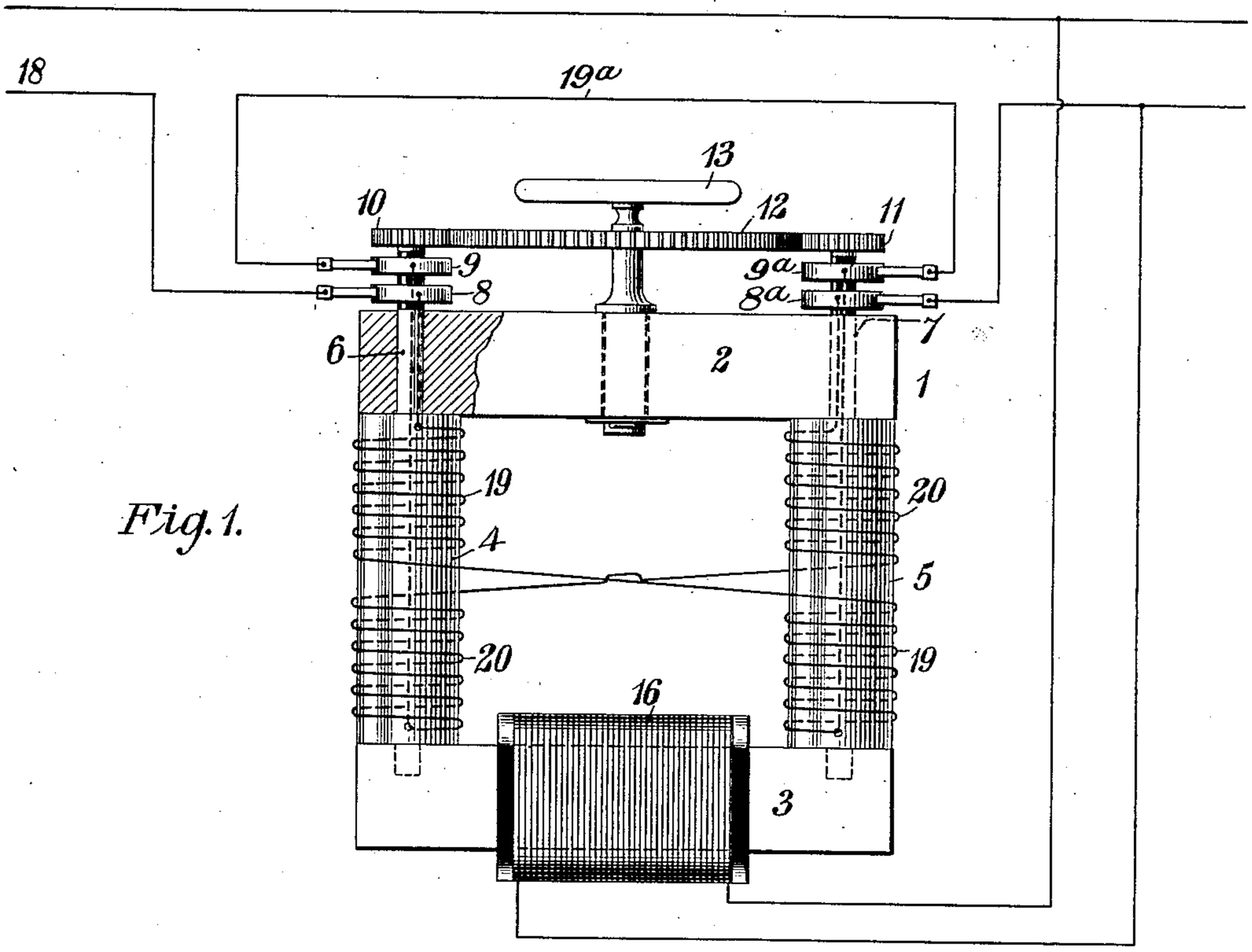

Fig. 1.

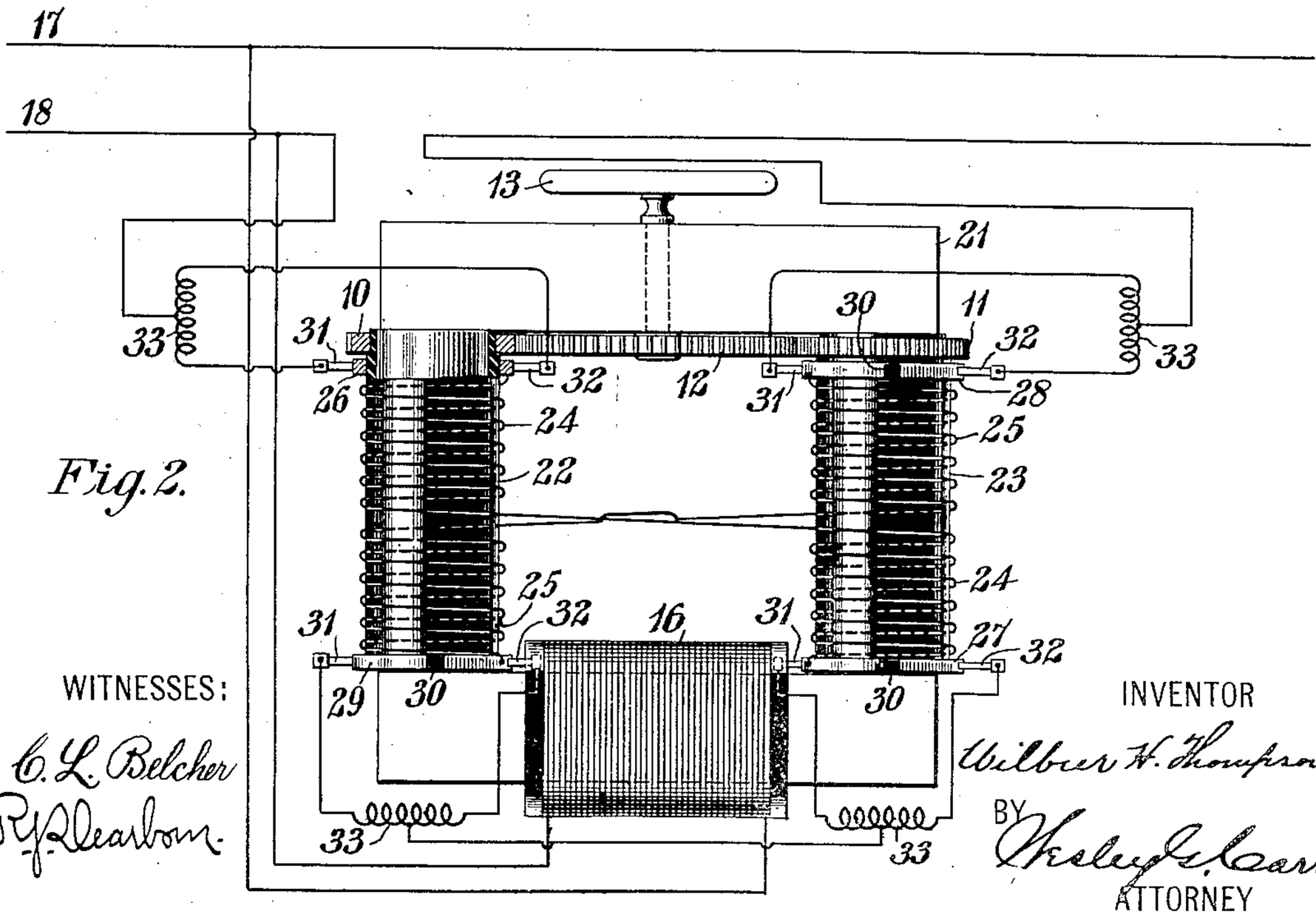

Fig. 2.

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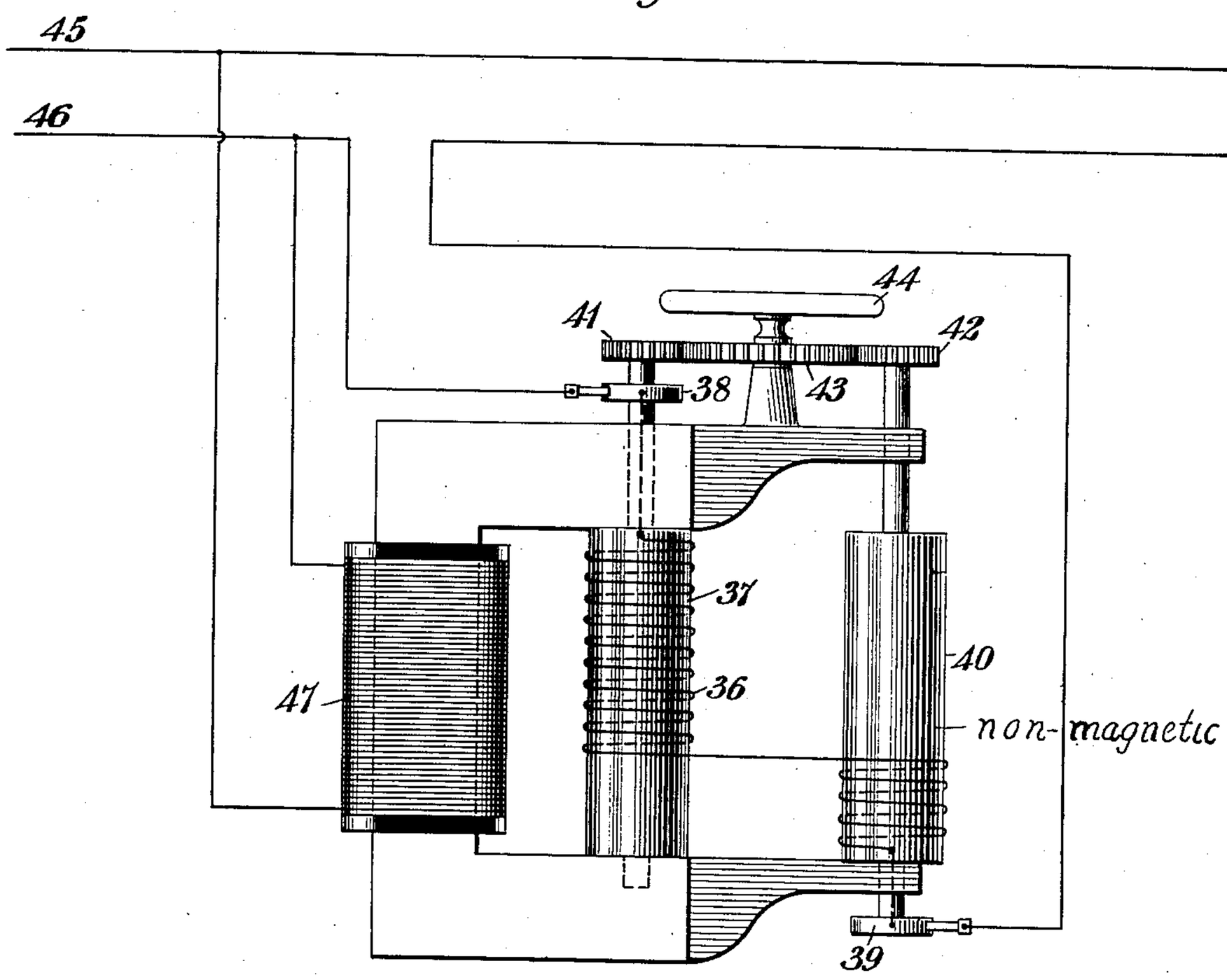
Fig. 3.



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ELECTRICAL APPARATUS.

No. 862,361. Specification of Letters Patent. Patented Aug. 6, 1907.

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To all whom it may concern:

Be it known that I, WILBUR H. THOMPSON, a citizen of the United States, and a resident of Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Electrical Apparatus, of which the following is a specification.

My invention relates to electrical apparatus and it has special reference to apparatus having means for varying the magnetizing effect of its winding or windings.

The object of my invention is to provide an apparatus of the general character above indicated that shall have a flexible winding which may be either disposed upon its core in two or more equal and opposing coils or be adjusted to provide either opposing or assisting turns of any number within the limits imposed by the length of the winding.

My invention is primarily intended for alternating current voltage regulation, and I will therefore describe it as applied to such use. I believe the invention to be of broader scope and suitable for other uses, however, and I therefore desire it to be understood that no specific application which may be hereinafter described shall be held to exclude any alternating current or direct current apparatus the structural and operative characteristics of which are the equivalents of those here set forth, even though such apparatus may be utilized in different relations to effect a specifically different result.

Potential regulators, as heretofore generally constructed, may be divided into two general classes, one of which embodies transformers having spaced leads to which one side of a circuit is successively connected to vary the voltage applied thereto and which therefore involves numerous circuit interruptions. The other class of regulators depends for its operation upon the position of a winding on a rotatable core with respect to a stationary winding which is in inductive relation thereto. This construction involves a considerable air-gap in the magnetic circuit and necessitates a careful alinement of the rotating member, which makes the construction relatively expensive.

The regulator of my invention may be constructed with a comparatively inexpensive core and may effect a wide regulation without circuit interruptions. In general, it comprises one or more flexible windings of cable, wire-braid or chain formation that may be readily wound, unwound and removed without injury to the conductor itself or to its insulation. In case the flexible winding is in two portions, they may be wound upon parallel portions of a magnetizable core, which are either rotatable with respect to the remainder of the core or are provided with rotatably mounted spools or bobbins, though the use of spools or bobbins was not originally proposed by me. One end of each flexible winding may be connected to a slip-ring which is mounted upon one of the rotatable core members or spools and the opposite end of the same winding may be connected to a slip-ring on the other rotatable core member or spool, so that the two windings may be continuously connected in series with each other and in series with a supply line. The flexible construction of the winding itself and the rotatable mounting provide means for transferring all or a portion of the turns of each winding from one of the core portions to the other, so that each core portion shall always have an invariable number of turns thereon.

When collector rings are mounted in such a position that the magnetic flux in the core passes through them, it is advisable to provide an opening in the ring in which insulation may be inserted to prevent the induction of a short-circuited current in the ring and, in regulation, where such short-circuited currents would be excessive, a pair of narrow brushes, which are connected by an inductive or other suitable resistance, may be advantageously employed to engage the ring at different points, the circuit connection being made to the middle point of the interposed resistance instead of to a single brush, which would in some instances short-circuit the ring or break the circuit.

The turns of both portions of the flexible winding are so arranged that the electromotive forces induced in all the turns of both portions may be added together and act in one direction, or by simultaneously rotating the movable members of the core, the turns of one portion of the flexible winding may partially or wholly neutralize the turns of the other portion, or the electromotive forces generated may be added together in the opposite direction. In this way, if the magnetizable core is energized by a stationary winding connected across a constant potential supply circuit and if the flexible windings are connected in series with the same line by a simultaneous actuation of the two rotatable members of the core, the voltage delivered from the line may be varied from a maximum value obtained when all the turns are acting in the same direction, corresponding to that of the line voltage, to a minimum value obtained when all the turns act in opposition to the line voltage.

The principal advantage in providing two flexible portions, the turns of which may be interchanged in position, lies in the fact that the available space on the core is completely occupied at all times.

My invention is illustrated in the accompanying drawings, in which

Figure 1 is a diagrammatic view of a regulator constructed in accordance therewith, in which two portions of the core are rotatably mounted. Fig. 2 is a

similar view, in which spools or bobbins are rotatably mounted upon two parallel portions of a continuous core, and Fig. 3 is a diagrammatic view of a modified arrangement in which a single portion of a magnetizable core is rotatable.

Referring to Fig. 1, a magnetizable core 1 comprises two fixed body portions 2 and 3 and two parallel, rotatably-mounted portions 4 and 5. The rotatable portions 4 and 5 are provided with shaft extensions 6 and 7 upon which are mounted slip-rings 8, 8ª, 9 and 9ª and a pair of similar pinions 10 and 11. The rotatable portions may be simultaneously driven by the gear wheel 12 which engages the pinions 10 and 11 and may be actuated by any convenient means, such as a hand-wheel 13. A magnetizing winding 16 may be mounted upon the fixed core portion 3 and be connected across an electric supply line 17—18. One end of a flexible winding 19 is connected to the slip-ring 8 and is partially coiled about the rotatable portion 4, the remaining turns being wound upon the rotatable portion 5 and the other end being connected through the slip-rings 9ª and 9, which are connected by a conductor 19ª, to a similar winding 20, the remaining terminal of which is connected to the slip-ring 8ª. When the two portions 4 and 5 are simultaneously rotated in the same direction, the turns of both flexible windings are transferred from one portion to the other until they are all interchanged. In this way, the available space of the two core portions may be entirely occupied at all times by the proper rotation of the core portions, and the turns of the flexible windings may all act in the one direction or the other, or may entirely oppose each other when the slip-rings 8 and 8ª are connected in series with the interrupted line conductor 18, which causes the entire current supplied from the line 17 and 18 to pass through the two flexible windings.

Referring now to Fig. 2 of the drawings, portions of the magnetizable core 21 that correspond in position to the portions 4 and 5 of Fig. 1 are respectively provided with spools or bobbins 22 and 23 upon which are coiled flexible windings 24 and 25. The ends of winding 24 are connected to slip-rings 26 and 27 and the ends of the winding 25 are connected to slip-rings 28 and 29, rings 26 and 29 being mounted upon the respective ends of the spool 22 and rings 28 and 27 being mounted upon the respective ends of spool 23. A small segment of each ring is removed and is replaced by a segment 30 of insulating material in order to avoid the generation of currents in the rings.

Each of the rings is provided with two brushes 31 and 32 that are connected to the terminals of a preventive resistance 33, the middle points of the resistances that are attached to the brushes making contact with the rings 26 and 28 being connected to the terminals of the interrupted line conductor 18 in order to connect the flexible winding in series in the circuit 17—18, and at the same time to avoid harmful short-circuits, and the middle points of the resistances 33 that are connected to the brushes that make contact with the rings 27 and 29 being connected together.

In case a wide variation in voltage is not necessary, the construction of the core may be simplified and made of smaller dimensions, by means of a modification which is disclosed in Fig. 3, in which a flexible winding 36 is wound upon a rotatable core portion 37, one end being connected to a slip-ring 38 attached to the portion 37 and the other end being connected to a slip-ring 39 which is mounted on the shaft of a rotatable drum 40 of non-magnetizable material.

The rotatable members 37 and 40 are provided with pinions 41 and 42 which are engaged by a driving gear wheel 43. The driving gear wheel 43 may be operated by any convenient means, such as a hand-wheel 44. By this arrangement, the simultaneous rotation of the members 37 and 40 transfers one or more of the turns from the magnetizing core portion 37 to the drum 40, thus providing a regulation from a normal voltage of a supply line 45—46 when all the turns are on the drum 40 to a maximum variation therefrom when all the turns are upon the magnetizable portion 37. The flexible winding is connected in series with the line 45—46 and the core may be magnetized in the usual manner by a winding 47, which may be connected across the line 45—46.

I claim as my invention:

1. The combination with a magnetizable member comprising two opposite fixed portions, a primary winding located thereon, and two opposite rotatable portions adjacent to the fixed portions, of a flexible secondary winding that is transferable, in whole or in part, from one of said rotatable portions to the other.

2. The combination with a magnetizable core comprising two rotatable portions, of a flexible winding the turns of which may be transferred to either core portion or be distributed between the two.

3. The combination with a magnetizable core comprising two opposite rotatable portions and adjacent fixed portions, of a flexible winding the turns of which may be concentrated on either one of the rotatable portions or be distributed between them.

4. The combination with a magnetizable core comprising two opposite rotatable portions, adjacent fixed portions and a magnetizing winding located thereon, of a flexible winding the turns of which may be transferred from one rotatable core portion to the other so that they will either aid the fixed winding or act in opposition thereto.

5. The combination with a magnetizable core and a magnetizing winding therefor, of a flexible secondary winding that is mounted upon parallel core portions, and means for transferring the turns of said flexible winding to provide either two coils or four coils.

6. The combination with a magnetizable core and a magnetizing winding therefor, of a flexible regulating winding that is mounted upon parallel core portions, and means for transferring the turns of said winding to provide four coils of equal length, four coils of unequal length or two coils of equal length.

7. The combination with a fixed magnetizing winding and a magnetizable core two portions of which are rotatable, of a pair of similar flexible windings connected in series and wound on said rotatable portions, and means for interchanging a part or all of the turns of said flexible windings.

8. The combination with a magnetizable core, two parallel portions of which are rotatable, a fixed magnetizing winding mounted on said core and two similar flexible windings that are mounted on said rotatable core portions and are connected in series, of means for rotating said core portions to effect transference of the turns of the two flexible windings.

9. A voltage regulator that comprises a magnetizable core, two portions of which are rotatable, a fixed magnetizing winding mounted on said core and two similar flexible windings that are mounted on said rotatable core portions and are connected in series.

10. The combination with a magnetizable core, a magnetizing winding therefor and two similar flexible windings which are mounted on two rotatable portions of said core, and are so connected that the electromotive forces induced therein are added together, of means for inter-

changing a part or all of the turns of the flexible windings so that the electromotive forces induced therein partially or wholly neutralize each other.

11. The combination with a magnetizable core, a magnetizing winding therefor, and two similar flexible windings that are mounted upon rotatable portions of said core, said flexible windings being so connected that the electromotive forces induced therein are added together, of means for interchanging a part or all of the turns of the windings so that the electromotive forces induced therein are partially or wholly opposite in direction.

12. The combination with a magnetic circuit that comprises a continuous magnetizable core on two rotatable portions of which are mounted flexible windings, of means for interchanging a part or all of the turns of the windings so that the electromotive forces induced therein are partially or wholly opposite in direction.

13. The combination with a magnetizable core two portions of which are rotatably mounted, and a magnetizing winding therefor, of a flexible winding which is mounted on said rotatable portions and means for simultaneously rotating said portions comprising a driving gear wheel and a pair of pinions which are fixed to shaft extensions of the rotatable portions.

14. The combination with a magnetizable core, a pair of similar, rotatably mounted portions thereof being provided with shaft extensions, pinions attached thereto, a magnetizing winding for said core, and means for simultaneously rotating said portions that comprises a driving wheel which engages said pinions, of a winding composed of flexible conductors and mounted on the rotatable core portions.

15. The combination with a magnetizable core, a pair of similar, rotatably mounted portions thereof being provided with shaft extensions, pinions attached thereto, a magnetizing winding for said core, and means for simultaneously rotating said portions that comprises a driving wheel which engages said pinions, of a winding that is composed of flexible conductors and is mounted on the rotatable core portions, and means for varying the electromotive force induced in the flexible winding without interrupting the circuit connections.

16. The combination with an alternating current supply circuit, a magnetizing winding that is connected across the circuit and is mounted on a magnetizable core, two similar portions of which are rotatably mounted, of a pair of flexible secondary windings that are disposed upon the rotatable core portions and are connected in series with the supply circuit, the positions of a part or all of the turns of the flexible winding being interchanged as the said core portions are simultaneously rotated, without interrupting the circuit connections.

In testimony whereof, I have hereunto subscribed my name this 12th day of July, 1905.

WILBUR H. THOMPSON.

Witnesses:

ALBERT C. LASHER,

BIRNEY HINES.