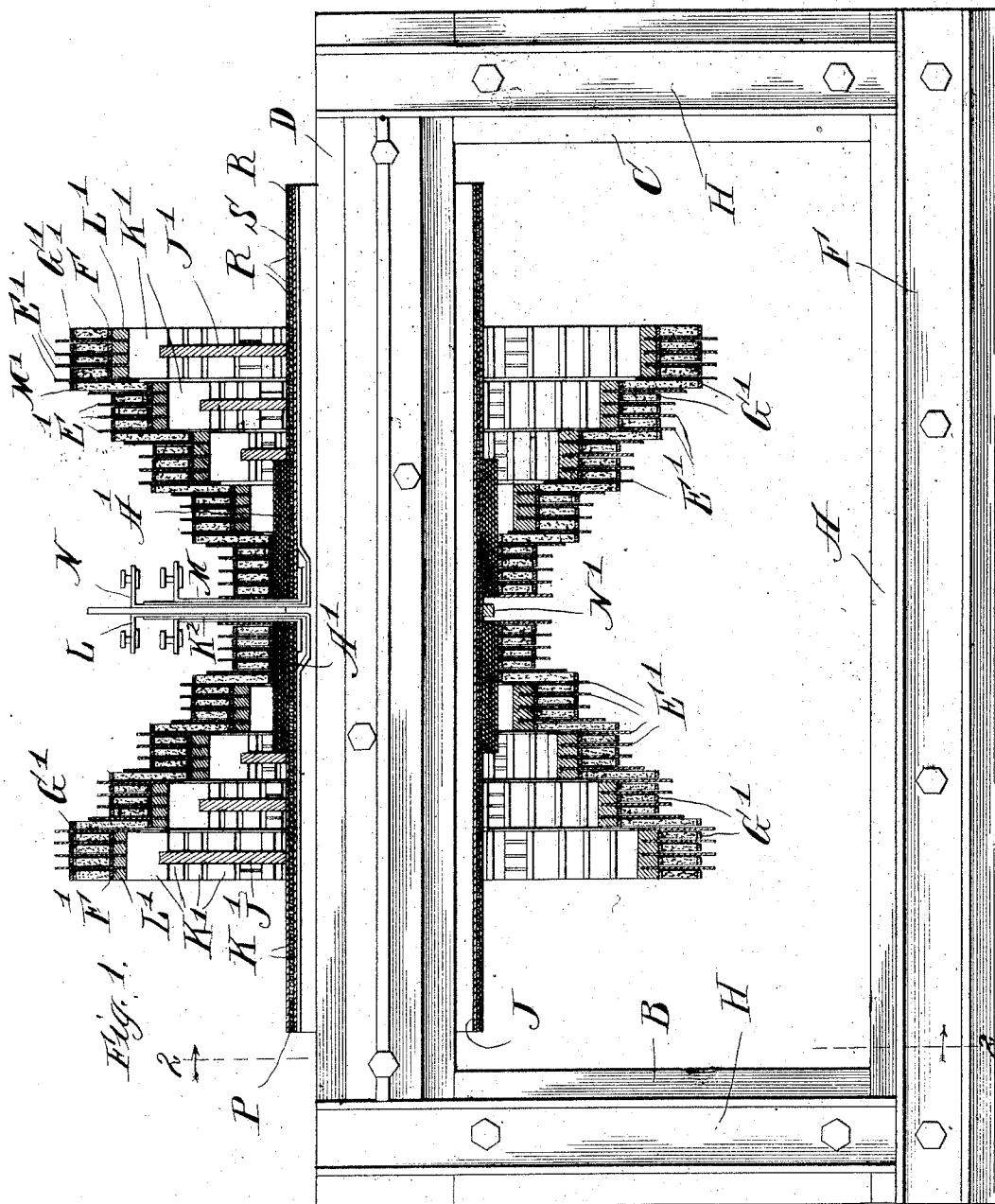


No. 880,838.

C. H. THORDARSON. PATENTED MAR. 3, 1908.
HIGH POTENTIAL TRANSFORMER.
APPLICATION FILED APR. 17, 1905.

3 SHEETS—SHEET 1.



Witnesses:

J. A. Paulschmitt

E. C. Sample

Inventor:

Chester H. Thordarson

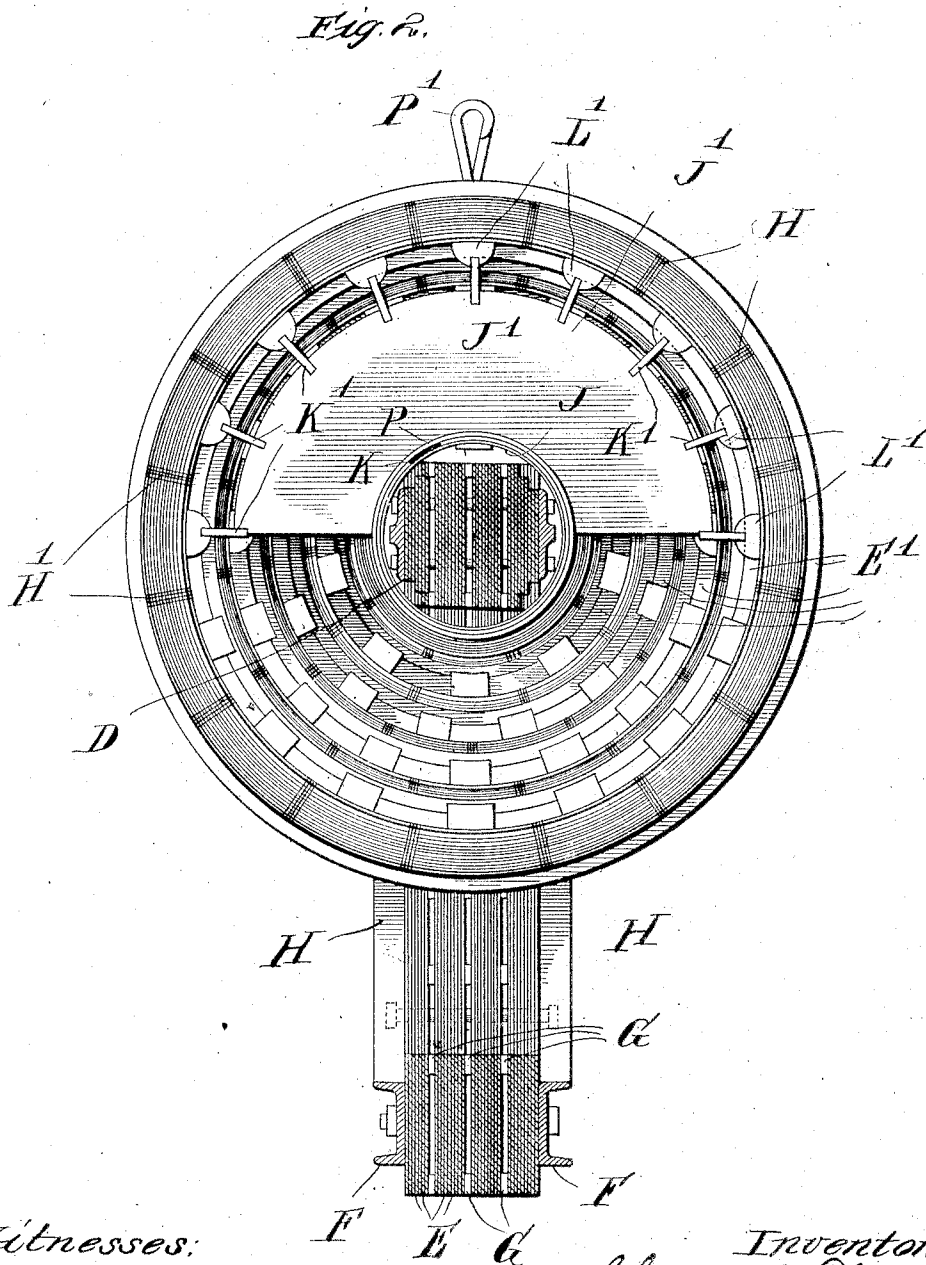
By Moore & Darby

Attys

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3 SHEETS—SHEET 2.



Witnesses:

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HIGH POTENTIAL TRANSFORMER.

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3 SHEETS—SHEET 3.

Fig. 3

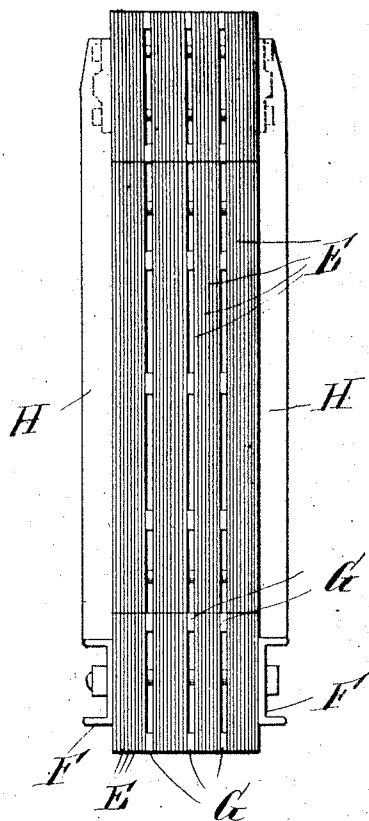


Fig. 5

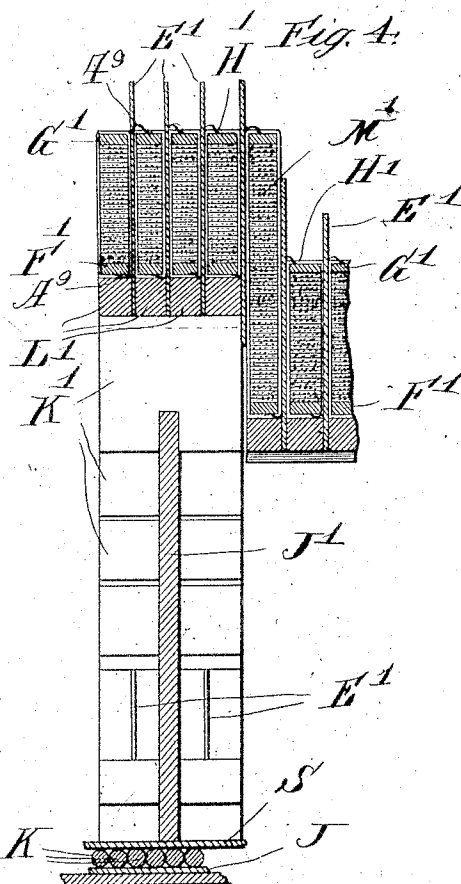
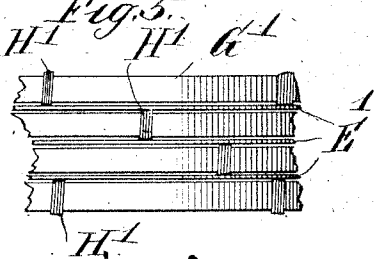


Fig. 6

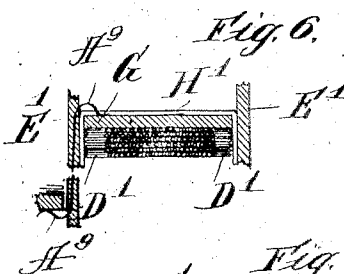


Fig. 7



Witnesses:
G. W. Pankuschmidt
E. C. Semple.

Inventor:
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UNITED STATES PATENT OFFICE.

CHESTER H. THORDARSON, OF CHICAGO, ILLINOIS.

HIGH-POTENTIAL TRANSFORMER.

No. 880,838.

Specification of Letters Patent.

Patented March 3, 1908.

Application filed April 17, 1905. Serial No. 255,892.

To all whom it may concern:

Be it known that I, CHESTER H. THORDARSON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful High-Potential Transformer, of which the following is a specification.

This invention relates to high potential transformers.

The object of the invention is to provide a construction of high potential transformer which is simple and efficient, and wherein efficient insulation is provided.

Other objects of the invention will appear more fully hereinafter.

The invention consists substantially in the construction, combination, location and arrangement of parts, all as will be more fully hereinafter set forth, as shown in the accompanying drawings, and finally pointed out in the appended claims.

Referring to the accompanying drawings, and to the various views and reference signs appearing thereon,—Figure 1 is a view, partly in side elevation and partly in vertical central section, of a construction of high potential transformer embodying the principles of my invention. Fig. 2 is a view in vertical transverse section on the line 2, 2, Fig. 1, looking in the direction of the arrows. Fig. 3 is an end view of the frame. Fig. 4 is a broken detail view in vertical longitudinal section of a portion of the secondary windings or coils, showing the manner of supporting the same. Fig. 5 is a broken detail view in plan of one of the sets of secondary coils or windings. Fig. 6 is a broken detail view in transverse section of a secondary coil or winding. Fig. 7 is a detail view in transverse section of one of the layers of windings composing a secondary coil.

The same part is designated by the same reference sign wherever it occurs throughout the several views.

In carrying out my invention I propose to employ a framework forming a magnetic circuit, and comprising a base upon which, and adjacent ends thereof, are supported end pieces, the latter forming supports for a transversely extending bar, the whole when assembled forming a substantially rectangular frame. The top and base portions, as well as the end portions, are formed of plates of magnetic material, such, for instance, as iron, placed flatwise against each other and suitably bolted or clamped together, the end

and top and bottom pieces of the frame, however, being wholly independent of each other and capable of being removed from each other—that is, without any means of attachment to each other, the end pieces resting loosely endwise upon the base portion, with the laminations composing the end pieces resting in surface contact with the laminations composing the base portion, and similarly, the top portion of the frame resting loosely upon the upper ends of the end pieces with the laminations of said parts respectively contacting with each other; and upon the top part or cross-bar I place the transformer coils, primary and secondary, it being the special object of the present invention to provide an exceedingly simple but efficient high power transformer.

In the accompanying drawings, reference sign A designates the base part of the framework, B and C the end pieces, and D the top piece or cross bar. The structure of each of these parts is substantially the same, and a description of one will apply to all. Take, for instance, the base part A. This part comprises a series of iron plates E, placed flatwise the one upon the other, and suitably clamped or bolted between side plates F. The plates or laminations E are all of equal length, and if desired they may be arranged in groups, and the groups separated from each other through suitable interspersed spacing blocks G. The end pieces B C are of similar construction and arrangement, except that the clamp-plates H thereof are of greater length than the plates or laminations composing said end parts, thereby affording means, when the parts are assembled, for properly holding and guiding the parts with respect to each other, the lower ends of the clamp-plates H of the end pieces straddling over the laminated body of the base, and the upper ends of the clamp-plates H forming a fork or crotch in which are received the ends of the top part D. In practice the magnetic bodies of the top and base parts and of the end parts are of equal transverse dimensions.

The top or cross bar D constitutes and forms the core for the transformer coils. These coils, both primary and secondary, are of special design and relative arrangement, and are applied to the core in a special manner, which I will now proceed to describe. Suitably sleeved upon the core D is a cylinder J of heavy insulating material,

and capable of being slipped endwise upon the core. Upon this cylinder of insulating material, beginning at a point about the transverse medial line thereof and extending to the respective ends thereof, I apply primary coils. In practice I employ only a single layer of coils in this winding, although I do not desire to be limited or restricted in this respect, and ordinarily, but without being limited or restricted thereto, I employ for each winding six wires, indicated at K (see Fig. 4), placed in parallel relation with each other, and spirally wrapped around the insulating cylinder J, beginning at a point adjacent the transverse medial line of the insulating cylinder and continuing in a single layer from such medial line to the respective ends of the insulating cylinder. I employ terminal connections K^2 L M N, the terminal connection K^2 being soldered or otherwise connected electrically to the inner ends of the primary coil K which are applied to one end of the insulating cylinder; while the terminal connection L is connected electrically at the point P with the extreme outer ends of the primary coils; and similarly, the terminal connection M is in electrical connection, by soldering or otherwise, with the inner ends of the primary coils comprising the winding applied to the other end of the insulating cylinder; while terminal N is similarly connected to the extreme outer ends of said primary coils at the point marked R, Fig. 1, the terminal connections being led in suitable or convenient relation for proper connection to the leading conductors of the circuit to be fed from the transformer, and it is obvious that these terminal connections may in practice be coupled together in any suitable or convenient relation with respect to each other, according to the work to be performed or the duty required. Suitably inclosing the conductors K, or the primary coil composed of such conductors, is a heavy insulating cylinder or casing S. Suitably supported upon, and in encircling or concentric relation with respect to, coils K and core D, are the secondary coils. These coils are of special construction and design, as will more fully appear hereafter, and are arranged in sets of increasing diameter from the medial line outwardly towards the end of the core, as most clearly shown in Figs. 1 and 4. The extreme inner sets of the secondary coils, which are the smallest in diameter, are respectively arranged on opposite sides of the transverse medial line of the core and insulating sleeves J and S, these coils being sleeved upon heavy insulating rings or cylinders A'. The secondary coils are all of the same construction and arrangement, varying from each other merely in diameter; and similarly, the various sets of coils are identical with each other except as to their diameters and the manner of sup-

porting the same. Therefore, a description of one coil and of one set of coils will answer for a description of all the coils and sets. Each coil is composed of a single layer of conductors in the form of a wrapping, indicated at B', Fig. 7. This layer is applied to a band of suitable insulating material, indicated at C', which if desired may comprise merely a ring of paper, which, however, possesses the characteristic of having the edges thereof folded or bent back upon the main body portion, as indicated at D', Figs. 6 and 7, thereby forming in effect a slight depression or seat between the edges of the folded portions to receive the winding B', said folded edges serving to prevent the lateral displacement of the coils B'. A desirable number of these wrappings or windings in the form of rings are assembled the one upon the other in inclosing relation to form a secondary coil, as clearly indicated in Fig. 6, the paper rings C' separating the successive secondary coils.

A series of coils constructed as above described are assembled along-side each other to form a set of secondary coils, but with suitable insulating disks E' interposed between adjacent coils of each set. In practice I prefer to employ insulating disks E' for each set, of greater diameter than the exterior diameter of the coils composing such set, in order to more thoroughly insulate the coils from each other, and to avoid danger of sparks occurring between adjacent coils under the high electrical tension or pressure developed. To the same end, each coil is wound upon a metal ring F', and is inclosed within a corresponding metal ring G'. The object of these metal rings is to afford means for supporting the coils and holding the same rigidly in proper shape, and also to protect the metal of the coil windings from burning out in case of arcing or sparking, and further, to afford means for connecting up adjacent coils in circuit with each other through the metal conducting strips indicated at A², Fig. 4, and passing diagonally through the insulating disks E' from the ring G' of one coil to the ring F' of the next adjacent coil.

In practice I prefer to slightly off-set the individual coils of each set of coils from each other, or, rather, from the interposed insulating disks E'. This may be accomplished in many specifically different ways. I have shown one simple and efficient manner of accomplishing this object, wherein I apply around each coil and transversely thereof, at suitable intervals, a wrapping of thread or cord, indicated at H'. These thread or cord wrappings not only serve to hold the conductors composing the individual layers of the coils, and their interposed paper rings C', in proper shape, but they also serve to slightly off-set the coils from the adjacent insulating disks E', thereby forming spaces be-

tween the coils and the insulating disks of the same set. As above stated, the various sets of coils are of substantially identical construction and relation with respect to the individual members thereof, except that, beginning with the inner set, the various succeeding sets are of increasing diameter. The sets of larger diameter may be supported in concentric relation with respect to the core D in many specifically different ways. I have shown a simple and efficient manner of supporting the sets of enlarged diameter in this relation, to which, however, I do not desire to be limited or restricted, and wherein I employ a segment plate J' for each set of coils of enlarged diameter, said segment J' resting upon the insulating cylinder S which incloses the primary windings K, and carried by the periphery of the insulating segment plate J', at suitably spaced distances apart, are plates K' of insulating material, and extending in transverse relation with respect to the segment J', and, as shown, seated in transverse peripheral grooves in the segment plate. Suitably supported by these plates K' are blocks L' which serve as supports for the secondary coils. In practice the insulating disks E' which are interposed between individual coils composing the sets, rest and are supported upon the transverse supporting plates K', whereas the coils themselves rest and are supported upon the blocks L'. Thus the insulating disks are not only of greater exterior diameter than the coils between which they are placed, but in the case of the coils of larger diameter, said insulating disks are of smaller interior diameter than said coils, thereby affording efficient insulation between adjacent coils. In practice the proximate coils of adjacent sets are formed into one coil, as indicated at M', though I do not desire to be limited or restricted in this respect.

In accordance with my invention, I so design and proportion and relatively arrange the parts that the space between the extreme outer or end coils and the end pieces B C of the frame is substantially the same as the distance or space between said coils and the base portion A of the frame, and I propose to so regulate the insulation of each layer of each coil, and between adjacent coils of each set, and between adjacent sets of coils, as that the combined insulation thereof, from the extreme outer to the extreme inner coil at each end of the core, is about equal to the insulation afforded by the space or gap between the extreme outer coils and the side or base portions of the frame.

In order that the transformer may be removed bodily with its core D from the frame of the machine, I may pass a strap (indicated at N') around the core and the conductor layer K and its inclosing insulating

sleeve at the medial line thereof, and provide such strap with a hook P', thereby enabling this entire part of the apparatus to be bodily removed.

It is designed to immerse the entire apparatus in oil during the practical operation thereof, and from the foregoing description it will be seen that by reason of the spacing blocks G interspersed throughout the laminations composing the base and core parts A D and the end pieces B C, and by reason of the separation of the individual coils composing each set from each other, and by reason of the peculiar manner of supporting the sets of coils of larger diameter as above described, provision is made for the oil to thoroughly enter between and circulate around every part of the apparatus, thereby affording additional insulation, and in this manner the wrapping thread or cord H', as well as the paper ring C', become impregnated with oil, thereby increasing the insulating effect thereof.

While I have specified paper rings C', I do not desire to be limited or restricted in this respect, as other materials might well answer the purpose.

It is obvious that many variations and changes in the details of construction and arrangement would readily occur to persons skilled in the art and still fall within the spirit and scope of my invention. I do not desire, therefore, to be limited or restricted to the exact details shown and described. But

Having now set forth the object and nature of my invention, and a construction embodying the principles thereof, what I claim as new and useful and of my own invention, and desire to secure by Letters Patent, is:

1. In a high potential transformer, a frame comprising a laminated base, laminated end pieces resting thereon and a core resting upon said end pieces, and transformer coils carried by said core.

2. In a high potential transformer, a frame comprising a magnetic base, and magnetic end pieces resting endwise thereon, and a magnetic core supported by said end pieces, in combination with transformer coils supported upon said core.

3. A high potential transformer comprising a rectangular frame, one of the side pieces thereof forming a core and the other forming a base, the end parts resting freely endwise upon the base part and freely supporting the core part, and transformer coils encircling the core part.

4. In a high potential transformer, a magnetic frame including a core, transformer coils encircling said core, said coils being respectively equally distant from the end and base portions of the frame.

5. In a high potential transformer, a frame

- comprising a laminated core, a laminated base and laminated end pieces, said end pieces resting upon said base and said core resting upon said end pieces, and transformer coils encircling said core, said transformer coils being respectively equally distant from the base and adjacent end portions.
6. In a high potential transformer, a magnetic base, core and end parts forming a frame, the end parts having clamp plates of greater length than the magnetic part, the ends of said clamp plates embracing respectively the base part and the core part, and transformer coils encircling the core part.
7. In a high potential transformer, a laminated magnetic base, core and end parts forming a frame, spacing means interposed in said laminated parts, and transformer coils encircling said core part.
8. In a high potential transformer, a core, a primary winding applied thereto and a secondary winding increasing in diameter from a transverse medial line, and terminal connections for the respective ends of said primary winding.
9. In a high potential transformer, a laminated core, a primary winding applied thereto from the transverse medial line towards the respective ends thereof, and terminal connections for the respective ends of each winding.
10. In a high potential transformer, a magnetic core, an insulating sleeve inclosing the same, primary windings applied from a transverse medial line and in a single layer toward each end of such core, medial terminal connections for the respective ends of each winding and secondary windings increasing in diameter around said primary winding.
11. In a high potential transformer, a laminated core, primary coils applied thereto, but insulated therefrom, from a transverse medial line towards each end thereof, terminal connections for the respective ends of said primary coils, and secondary coils encircling said primary coils, but insulated therefrom, said secondary coils being of increasing diameter towards the respective ends of said core.
12. In a high potential transformer, a core, a primary wrapping applied to each end of said core from a transverse medial line, and a series of secondary coils concentric with said core but of increasing diameter from the transverse medial line of said core towards the respective ends thereof.
13. In a high potential transformer, a core, a primary wrapping applied thereto from a transverse medial line towards the respective ends thereof, a series of secondary coils supported in concentric relation with respect to said core and primary wrapping and arranged in sets, said sets of secondary coils being of increasing diameter from the transverse medial line of the core towards the respective ends thereof.
14. In a high potential transformer, a core, a primary wrapping applied thereto, and a secondary coil encircling said wrapping but insulated therefrom, said coil comprising successive layers of spirally wrapped conductors, and insulating rings interposed between said layers.
15. In a high potential transformer, a core, a primary wrapping therefor, a secondary coil encircling said wrapping and core and comprising a plurality of conductor layers, an insulating ring interposed between each secondary layer, said rings having the edges thereof turned or bent back upon themselves to maintain the conductors of the layer in proper relation.
16. In a high potential transformer, a core, a primary wrapping therefor, a secondary coil encircling said core and primary and including insulating rings and interposed secondary layers, and an insulator interposed between successive secondary layers.
17. In a high potential transformer, a core, a primary wrapping applied thereto, and a secondary coil encircling said core and wrapping, said coil built up of successive conductor layers and interposed insulating rings, said rings having their edges bent or folded back upon the body thereof, and serving to maintain the conductor layers in proper relation, and means for insulating said coil.
18. In a high potential transformer, a core, a primary wrapping applied thereto, and secondary coils encircling said core and wrapping, and arranged in sets, and insulating disks interposed between the members of each set of coils.
19. In a high potential transformer, a core, a primary wrapping applied thereto, and secondary coils encircling said core and wrapping, and arranged in sets, insulating disks interposed between adjacent members of each set of coils, said disks being of greater exterior diameter than the diameters of the coils.
20. In a high potential transformer, a core, a primary wrapping applied thereto, secondary coils encircling said core and wrapping, each coil having a wrapping of thread or cord applied thereto at suitable distances apart, and insulating disks interposed between adjacent coils.
21. In a high potential transformer, a core, a primary wrapping applied thereto, and secondary coils encircling said core and wrapping, and means for supporting said coils concentric with said primary and core comprising a segment plate and supporting plates carried thereby at the periphery thereof, said supporting plates serving to support said coils.
22. In a high potential transformer, a

core, a primary wrapping applied thereto, and a secondary coil of larger interior diameter than the diameter of said primary and core, and means for supporting said coil concentric with said primary and core, comprising a transversely-extending segment plate, supporting plates carried at the periphery thereof, and blocks carried by said supporting plates, upon which said coil is supported.

23. An electric transformer, comprising means for producing a variable magnetic field of force, and a winding in the form of two hollow substantially truncated-conical sections symmetrically arranged in said field of force.

24. An electric transformer comprising a core, a primary winding thereon, and a secondary winding in the form of two symmetric hollow truncated cones, with their apexes meeting approximately the longitudinal center of the core.

25. An induction coil, comprising a laminated iron core, a primary winding of relatively coarse wire thereon, and a secondary winding of relatively fine wire in the form of two symmetric hollow cones serially connected, and with their sides converging towards the magnetic center of the core.

26. An induction coil, comprising a core, a primary winding thereon, an insulating tube about said primary winding, and a secondary winding in the form of two hollow truncated cones with their sides converging towards the magnetic center of said core, said cones being supported upon said insulating tube.

27. An induction coil, comprising a laminated iron core, a primary winding thereon,

and a secondary winding in the form of two symmetric hollow cones with their axes coinciding with the longitudinal axis of the core, and with their apexes meeting in the magnetic neutral plane of said core.

28. An induction coil, comprising a core, a primary winding thereon, and a secondary winding in the form of two substantially cone-shaped sections symmetrically arranged in the magnetic field of force of said core.

29. An induction coil, comprising a core, a primary winding thereon, and a secondary winding in two sections having a common center in approximately the plane of the magnetic center of the core, the convolutions of said sections progressively diverging from each other and from the core.

30. An induction coil, comprising a core, a primary winding thereon, and a secondary winding in the form of two hollow truncated cones whose interior and exterior walls are substantially parallel, said cones being arranged with their apexes meeting in substantially the plane of the magnetic center of said core, and with their windings serially connected.

31. An induction coil, comprising a core, a primary winding thereon, and a secondary winding in two sections the convolutions of which progressively diverge from each other and from the core.

In witness whereof, I have hereunto set my hand this 14th day of April 1905, in the presence of the subscribing witnesses.

CHESTER H. THORDARSON.

Witnesses:

E. C. SEMPLE,
S. E. DARBY.