No. 615,653. Patented Dec. 6, 1898.

T. B. KINRAIDE.

HIGH FREQUENCY INDUCTION APPARATUS.

(Application filed Mar. 4, 1898.)

(No Model.)

Fig. 1

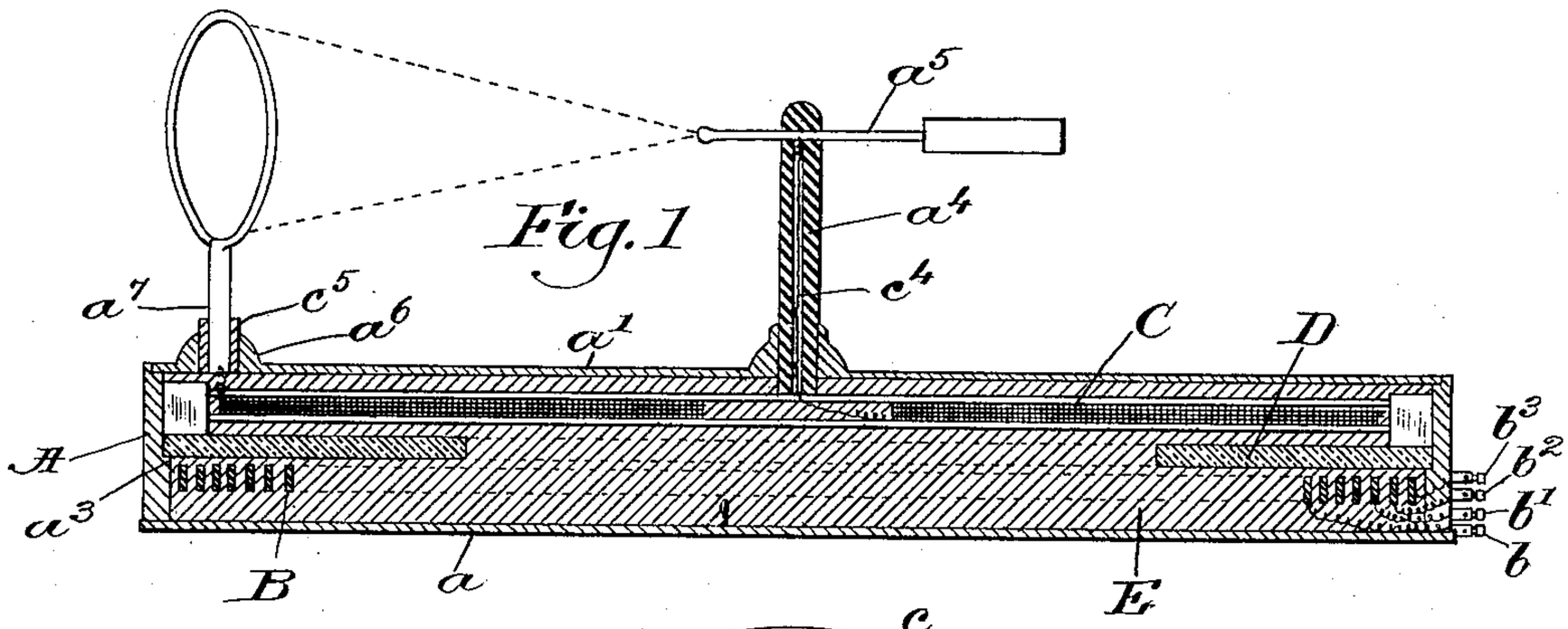


Fig. 2

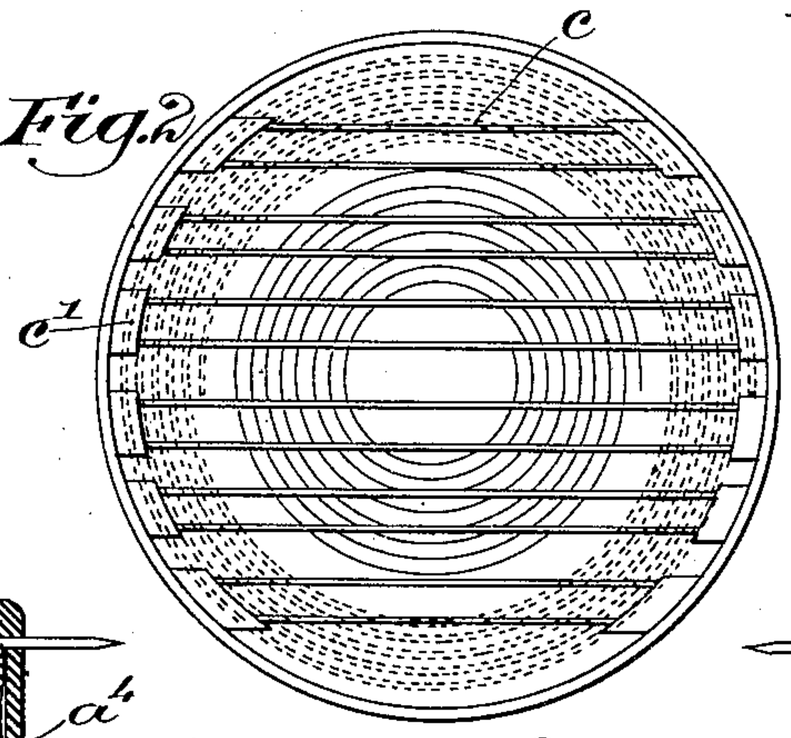


Fig. 3

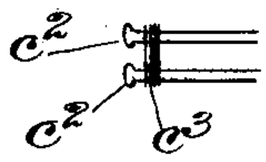


Fig. 4

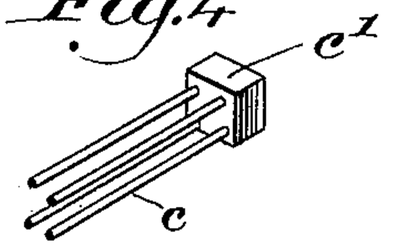


Fig. 5

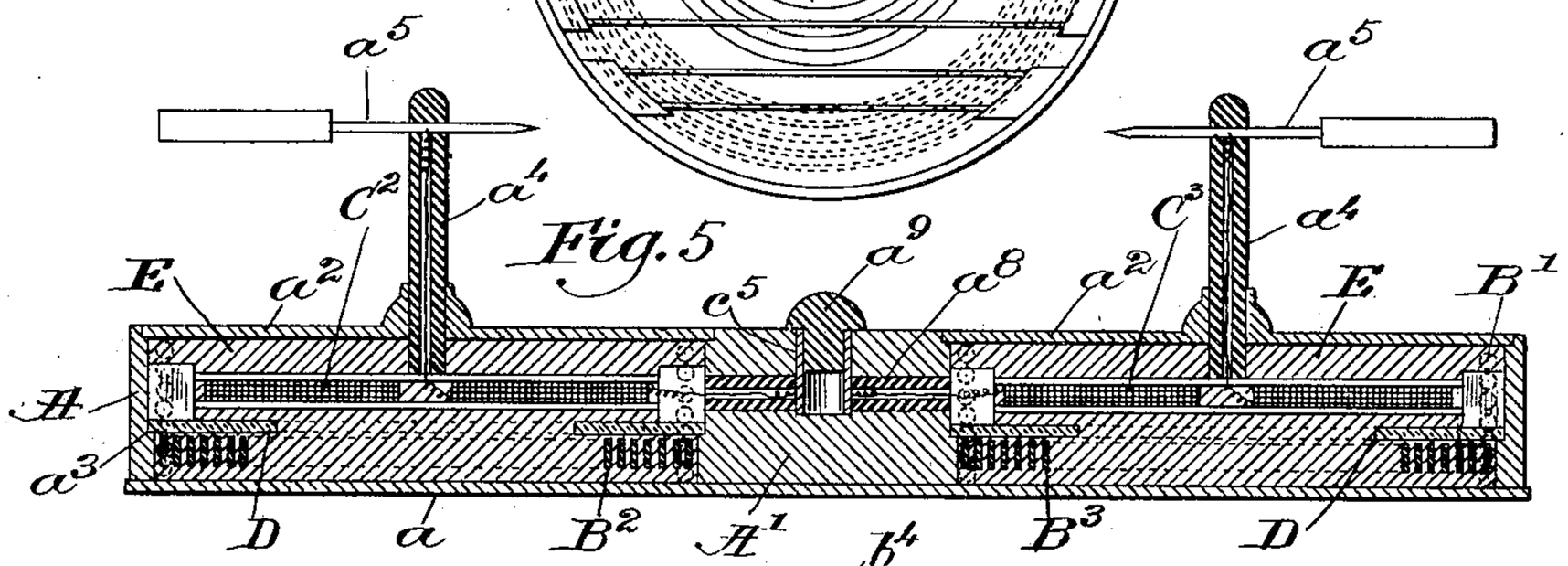
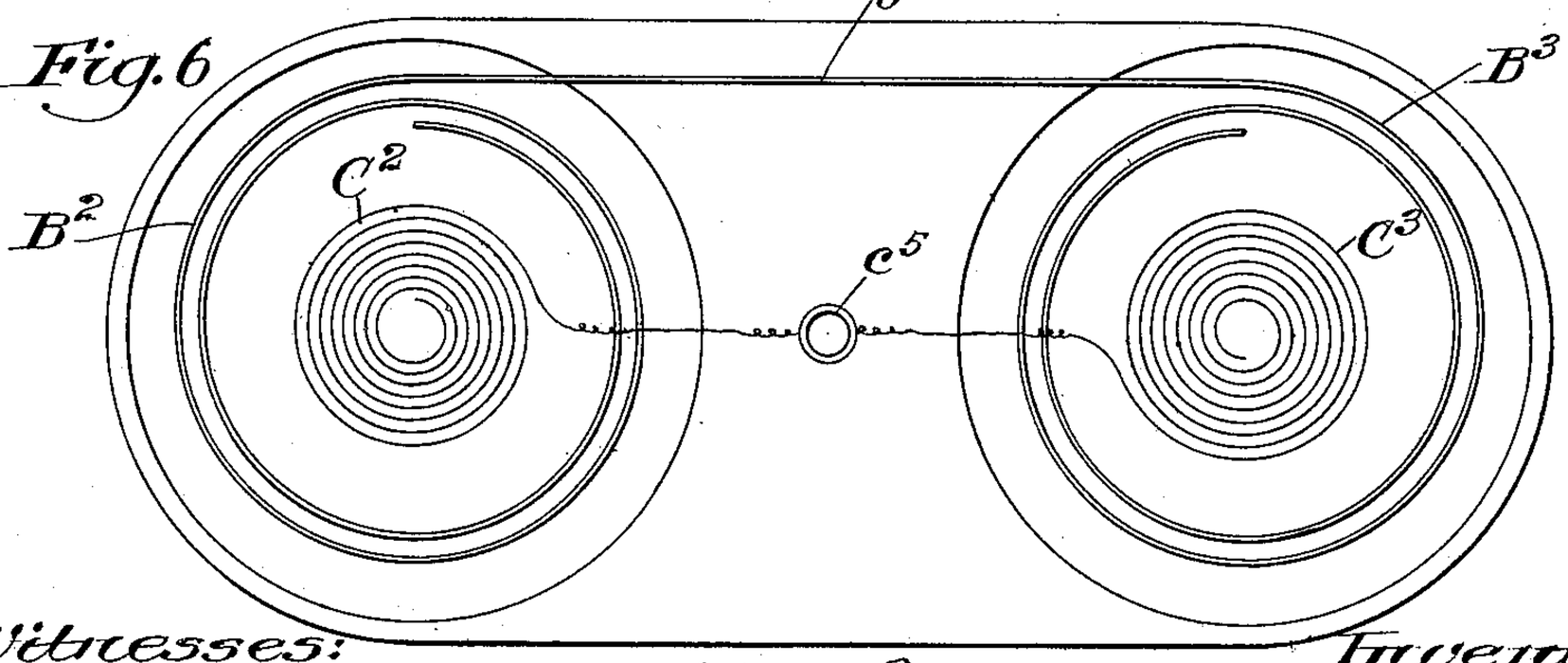
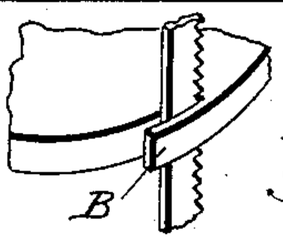


Fig. 6



Witnesses:
A. C. Harrow.
Walter E. Lombard.

Fig. 7.



Inventor.
Thomas B. Kinraide
by Crosby Gregory & Phillips.

UNITED STATES PATENT OFFICE.

THOMAS B. KINRAIDE, OF BOSTON, MASSACHUSETTS.

HIGH-FREQUENCY INDUCTION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 615,653, dated December 6, 1898.

Application filed March 4, 1898. Serial No. 672,531. (No model.)

To all whom it may concern:

Be it known that I, THOMAS B. KINRAIDE, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in High-Frequency Induction Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is an improvement in induction-coils, and has for its principal object the provision of an apparatus capable of unlimited high frequency without danger of self-destruction or breaking down.

Induction-coils as ordinarily constructed are wound in disk form, the disks being placed side by side, usually in a columnar or tubular form over a central core, so that of course the coils are shortest, and hence offer least resistance, at the centers of the disks or next the core, and the highest potential is at the outside—*i. e.*, at the circumference of the disk—where the coils are the longest. I have departed entirely from this principle and have produced a flat coil in which the highest voltage is at the shortest turns and the lowest voltage is at the longest turns, or, in other words, the voltage increases inversely as the resistance.

In its simplest form and preferred embodiment my invention comprises a coarse primary of few turns and a fine secondary of many turns, preferably coaxially arranged, and the primary being confined to the low voltage or circumferential portion of the secondary.

The details of construction and the more complete embodiment of my invention and the more striking phenomena thereof will be set forth in the course of the following description, reference being had to the accompanying drawings, and the invention will be more particularly defined in the appended claims.

In the drawings, in which I have shown preferred embodiments of my invention, Figure 1 is a central vertical section of a simple coil or apparatus, illustrating one form of my invention. Fig. 2 is a top plan view thereof, on a reduced scale and partly diagrammatic, in order to give a clear understanding thereof. Figs. 3 and 4 are perspective details of insulators or separators employed. Fig. 5 is a view similar to Fig. 1, showing a complete embodiment of my invention. Fig. 6 is a top plan view thereof, partly diagrammatic. Fig. 7 is a fragmentary view showing one way of making the coarse primary.

In a box A of any suitable shape and size desired, being herein shown in Figs. 1 and 2 as circular and in Figs. 5 and 6 as oblong with rounded ends, I mount a primary B and a secondary C, a partition D, preferably of glass, being interposed between the primary and secondary, if desired, although it may be omitted. The box A has preferably a removable bottom a and top a', Fig. 5, these parts being preferably constructed of vulcanite or other insulating material.

When a partition D is employed, a ledge a^3 may be molded, stamped, or turned, if desired, on the inner wall of the box, on which the partition may be seated, and for neatness of construction the top also will preferably rest on a similar ledge. The top and bottom may be screwed or otherwise secured to the edges of the walls or rim of the box, although I wish it understood that the details of the inclosing box may be infinitely varied within my invention.

I wind the secondary C, of fine wire and such area as is desired, in the form of a thin flat disk and secure it by suitable means in one of the sides of the box, herein shown as the upper side, the securing means being herein shown as comprising a plurality of glass rods c, arranged in pairs oppositely placed above and below the secondary and together constituting a holding-grid. It is obvious that this grid may be made in any form, the parallel bars being preferred merely for convenience. Having properly positioned the secondary between its holding-rods c or such other holding devices as may be used, I preferably connect the terminals of the secondary with a current sufficient to raise the secondary to a considerable heat and then pour into the box a melted insulating compound E, preferably of rosin and beeswax, sufficient to fill the box and entirely cover the secondary, preferably also covering the holding-rods c, as is indicated in the figures, maintaining the heat for a sufficient time to insure that the melted rosin and wax shall have permeated into every in-

terstice of the secondary and its neighboring parts. The primary is put in position in the same manner, excepting that no holding-grid is necessary therefor, inasmuch as the inherent rigidity of the coarse wires prevents any buckling or warping thereof under the action of the heated insulating compound. The result is that when the insulating compound has hardened the primary and the thin flat disk of the secondary are insulated absolutely.

In view of the fact that my secondary is made of such fine wire and in the form of a thin disk it is necessary that it should be positively held by a grid-like holder while the wax is being poured, as otherwise it would work out of shape.

The rods *c* may be held at their ends by glass blocks *c'*, as shown in Fig. 4, or a more convenient construction is that shown in Fig. 3, where it will be seen that the rods are severally provided with heads c^2 and are tied together simply by wrapping a piece of silk thread c^3 around the ends thereof. This latter construction is extremely convenient. These glass rods, it may be remarked, are also advantageous for holding thin or fragile conductors in various other relations than that herein shown.

It will be observed that the partition D is cut away at its middle portion, so that it will be understood that both sides, or, in other words, the entire apparatus, is poured at once with the insulating compound. The compound which I have mentioned is normally solid, and therefore there is no tendency in the apparatus to leak; but, on the contrary, it is substantially one piece or solid, without any danger of loosening or getting injured. Moreover, if from any cause whatever any heating effects have been produced at any point in the apparatus, it is evident that the fusible insulating compound would be softened or melted sufficiently to cause it automatically to flow around the heated portions and maintain perfect insulation.

I prefer to employ a primary made as illustrated in full lines in the figures, where it will be seen that it consists of a flat helix of coarse wire or metal, although it may be in other forms—for instance, as indicated in dotted lines at B' in Fig. 5. This helix B is conveniently made by sawing a piece of sheet metal to produce the form shown, (see Fig. 7,) the air-gap formed by the saw-cuts being sufficient in practice to insulate the primary, especially when embedded in the insulating compound, as explained.

I have shown both primary and secondary as circular, although it will be understood that they may be square, oval, or any other shape desired—oval, for instance, being preferable where it is desired to get a long spark-gap in an instrument of the form shown in Fig. 1.

In the above description I have purposely omitted all technical details of construction in order to present my invention in its broad features and in its simplicity, although it will be understood that proper binding-posts and connections will be provided, as indicated at b^2 b^3, Fig. 1, and that the other usual features of regulation will be used in connection therewith, including a break, condenser, &c. The inner terminal of the secondary is shown at c^4 as extending in a central post a^4 to a usual adjustable electrode a^5, and the opposite terminal of the secondary is shown in Fig. 1 as terminating at a thimble or ferrule c^5 in a socket a^6, which may contain any suitable electrode, a ring-discharger a^7 being shown in place therein.

Referring to Figs. 5 and 6, it will be seen that I have provided two primaries B^2 B^3, connected together at b^4, and two secondaries C^2 C^3, electrically connected by a contact ring or ferrule c^5 similar to that already described. The two primaries and secondaries are separated by an insulating-block A', which constitutes a portion of the box, and they are embedded in insulating compound precisely the same as described in the simpler form of the apparatus shown in Fig. 1, it being understood that the connecting-wires of the primary and secondary are carried through insulating-tubes, as is indicated at a^8, Fig. 5. The inner terminal of each of the secondaries C^2 C^3 connects with a central post a^4, containing an electrode a^5, as already described, and the thimble or ferrule c^5 (shown in Fig. 5 as stopped by a plug a^9) is adapted to receive a discharge-ring a^7 or any other form of electrode, although usually it will be stopped by the plug, as shown. The primary is restricted to the circumferential portion of the secondary—that is to say, it is located in the vicinity of the outer or larger turns of the secondary in the form of an annulus having a large central aperture. Besides this, I make the primary relatively short and of large cross-sectional area, the latter feature giving the primary large condenser or static capacity. Also there is an entire absence of any core or anything of that nature to produce sluggishness. The result is that I am enabled to obtain exceedingly high frequency without destructive heating.

The primary being entirely or mainly located at one side of or adjacent the circumferential portion of the secondary and there being no core of magnetic material, but only electrical inductive action, there results a piling up or condensing of the lines of force at the center of the secondary in an obvious vertical form, so that the potential or voltage of the inner portion of the coil is high and of the outer portion low. The intensity of the electrical field is enormously increased at the center of the coils and nearly all the lines of force of the entire coil are concentrated upon this central portion thereof, and the construction is such that this condition is maintained—that is to say, there is an enormous propulsive discharge from the electrode at the center of the coil and there is

scarcely any discharge from the outer electrode thereof at c^5. This will be understood by referring to Fig. 1, where I have indicated by dotted lines the discharge effects. The discharge takes place or may take place like radiant flames collected by a ring, as shown in Fig. 1, or by removing the ring or turning the electrode a^5 at some other angle this radiant discharge simply shoots out into space.

One great advantage besides that already pointed out of the high frequency and enormous discharge is that there is no fear of melting down the coil. Heretofore in induction-coils it has been necessary to exercise extreme care in regulating the discharge-terminals so as to prevent too great resistance between them, as otherwise the apparatus would at once short-circuit itself and quickly be ruined, whereas in my present invention all this is done away with.

While I have herein described a preferred embodiment of my invention, I wish it understood that very many changes and rearrangements may be resorted to without departing from the spirit and scope of the invention and that I am not limited otherwise to details than as expressed in the appended claims.

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

1. An induction device, comprising a secondary in the form of a flat coil, and a primary in the form of a flat coil, superimposed flatwise and coaxially one on the other, said primary being in the form of an annulus having a large central aperture relatively to the said coaxial secondary, as and for the purpose set forth.

2. An induction apparatus comprising a winding producing an exciting-field, and an electric conductor excited thereby, said conductor having a plurality of turns of varying lengths, said field-winding being located adjacent the longer of said turns, and the shortest of said turns having the highest voltage, substantially as described.

3. An induction apparatus comprising an electric conductor whose resistance per turn diminishes as its voltage increases, and an exciting-field winding adjacent and confined to the low-voltage portion of said conductor, substantially as described.

4. In an induction apparatus, a plurality of turns of electric conductor, said conductor being constructed and wound to present decrease of resistance in the turns toward one end with an increase of voltage toward the same end when under the influence of current, and means to maintain said high voltage at said end of minimum resistance per turn, substantially as described.

5. An induction device having a primary of sheet metal, the turns of said primary being insulated from each other by a saw-cut, substantially as described.

6. An induction device comprising a shallow box having a closed bottom and an intermediate partition, said partition extending to the walls of the box parallel to the bottom, a flat coil of a single thickness of wire being contained between the partition and the bottom of the box and confined to that portion thereof adjacent the walls of the box, and a flat coil constituting a secondary being contained in the box on the opposite side of said partition and extending approximately to the center of the box, the box being filled with, and said primary and secondary being embedded in, a fusible insulating substance normally solid, substantially as described.

7. An induction device comprising a shallow box having a closed bottom and an intermediate partition, said partition extending to the walls of the box parallel to the bottom, a flat coil of a single thickness of wire being contained between the partition and bottom of the box and confined to that portion thereof adjacent the walls of the box, and a flat coil constituting a secondary being contained in the box on the opposite side of said partition and extending approximately to the center of the box, the box being filled with, and said primary and secondary being embedded in, a fusible insulating substance normally solid, said secondary being retained from warping by means of an insulating-grid comprising bars extending across it both above and below, substantially as described.

8. An induction apparatus comprising a plurality of primaries connected together in series at one of their terminals, combined with a secondary for each primary, said primaries and secondaries being constructed and arranged to maintain high voltage at the center of each secondary, and low voltage at the circumferential terminals thereof, the inner terminal of one of said secondaries being positive and the inner terminal of the adjacent secondary being negative, substantially as described.

9. An induction apparatus comprising a plurality of primaries connected together in series at one of their terminals, combined with a separate secondary for each primary, said secondaries having regions of high voltage at their centers, and regions of low voltage at their circumferential terminals when the apparatus is in action, substantially as described.

10. An induction apparatus comprising a plurality of primaries connected together, and a secondary for each primary, said secondaries being respectively located substantially coaxially relatively to their primaries, and each being wholly or mainly within the primary, the latter being adjacent the circumferential portion of the secondary only, whereby a large propulsive discharge may be maintained at the central terminal of the secondary with an inappreciable discharge at the circumferential terminal thereof, substantially as described.

11. An induction apparatus comprising a

plurality of coarse, short, flat-coiled primaries connected together, and a corresponding plurality of long, fine secondaries wound in the form of flat coils, each primary being wound with a large central aperture, and having its coils restricted to the area adjacent the longer of the turns of its secondary, substantially as described.

12. An induction apparatus comprising a shallow box having a plurality of compartments and removable tops therefor, each compartment containing a coil constituting a primary, and a second coil constituting a secondary, said coils being coaxial with each other and the secondary extending within the primary, said coils being embedded in a fusible insulating substance normally solid and filling said several compartments, said box having insulated passages connecting said boxes, and said several primaries having one of their terminals communicating through said passages, and a discharge post or device for the central terminal of each secondary, substantially as described.

13. An induction device comprising a shallow box having a closed bottom, a flat coil of a single thickness of wire adjacent said bottom and confined adjacent the walls of the box, and a flat coil constituting a secondary winding contained in the box adjacent the other winding and extending approximately to the center of the box, said secondary winding being retained from warping by means of a plurality of glass bars arranged transversely thereof on opposite sides of the winding, the box being filled with and said primary and secondary being embedded in a fusible insulating substance normally solid, substantially as described.

14. An insulating-grid adapted to bind together and insulate a disk or other winding, said grid being composed of glass bars arranged opposite to each other on opposite sides of the winding and projecting therebeyond at their ends, said ends having heads adapted to be bound together by a filament, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. KINRAIDE.

Witnesses:

GEO. H. MAXWELL,

ALEXANDER C. PROUDFIT.