No. 744,018. PATENTED NOV. 17, 1903.

E. L. AIKEN.

METHOD OF FORMING COILS FOR ELECTRICAL APPARATUS.

APPLICATION FILED DEC. 5, 1898. 3 SHEETS—SHEET 1.

NO MODEL.

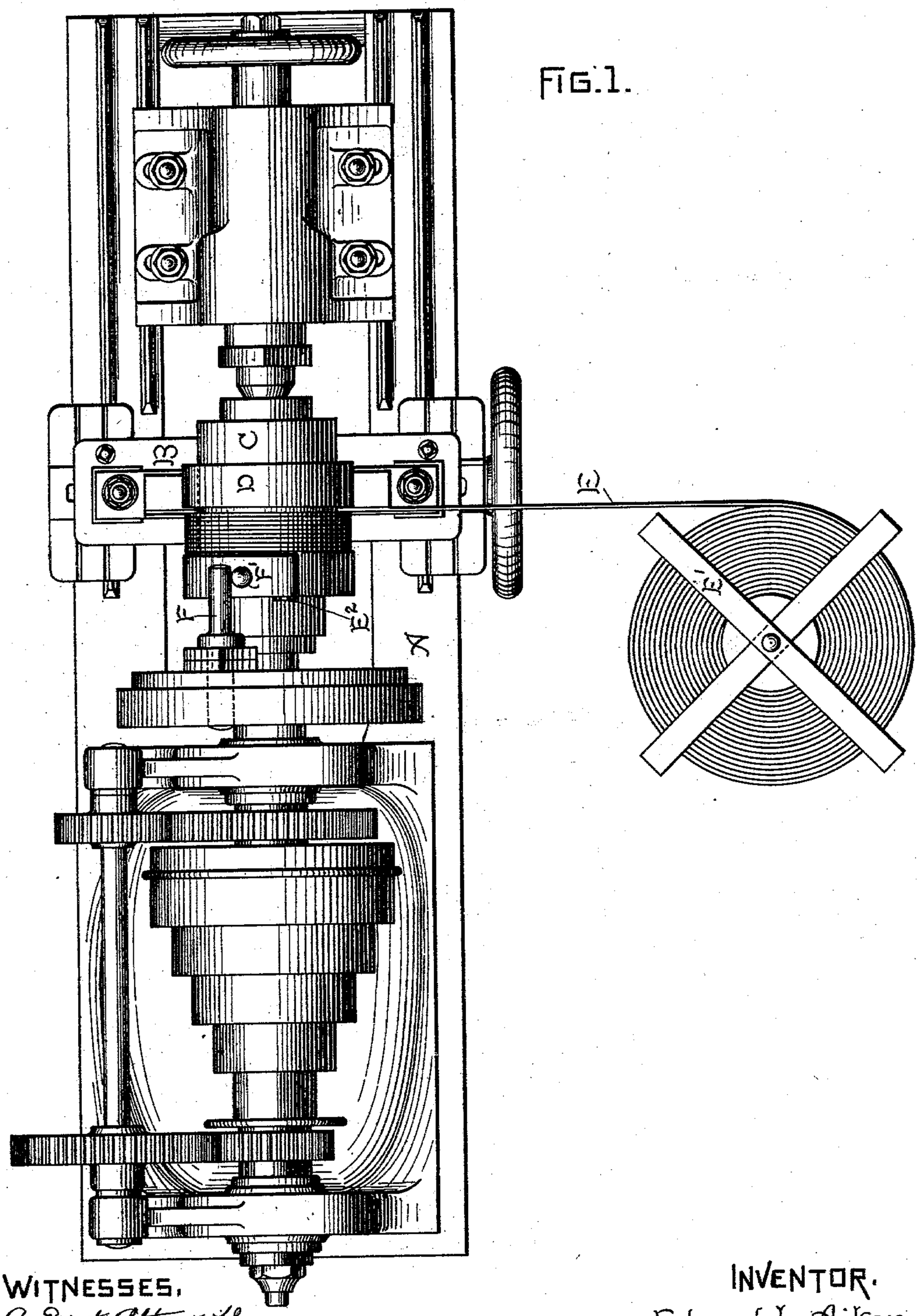

FIG. 1.

WITNESSES.

A. Ernst Attenpohl.

A. F. Macdonald.

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Edward L. Aiken

by Albert G. Davis

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NO MODEL. 3 SHEETS—SHEET 2.

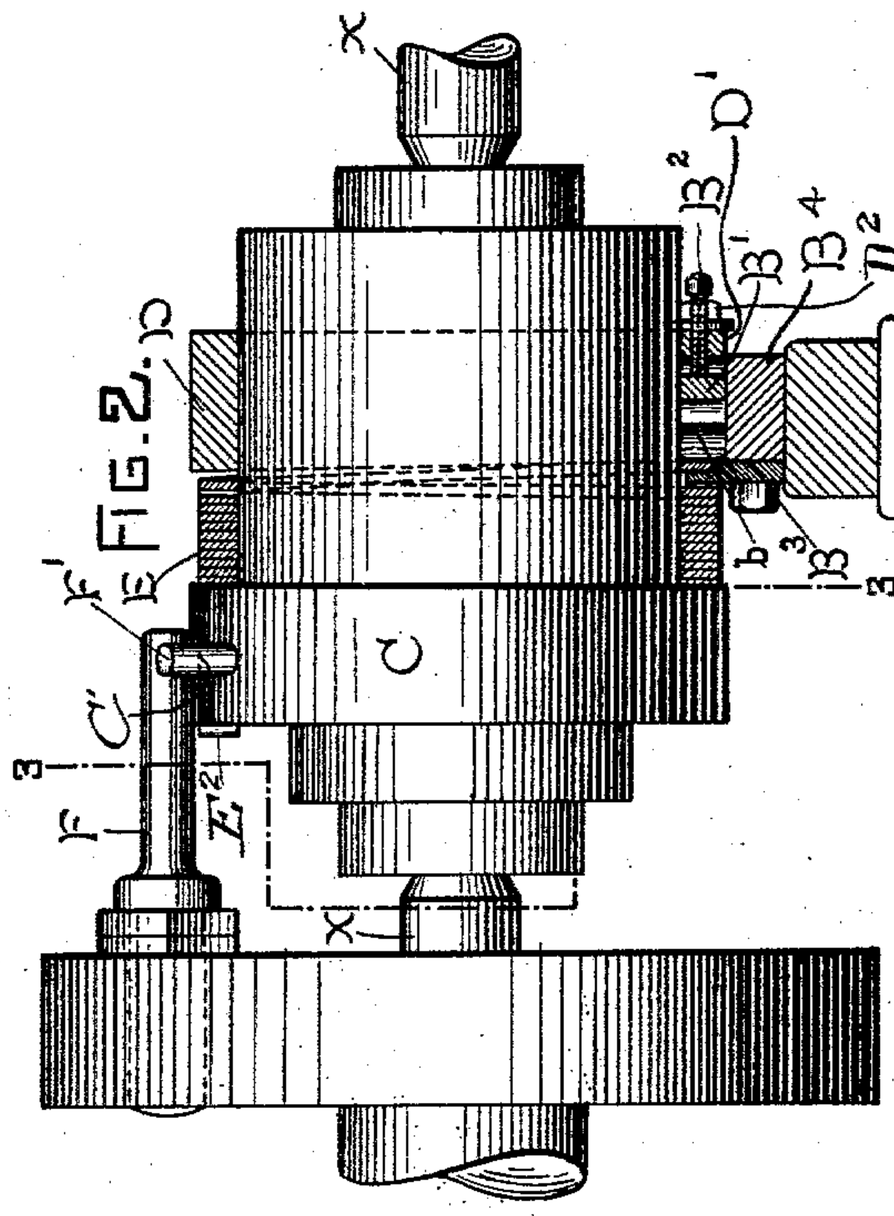

FIG. 2.

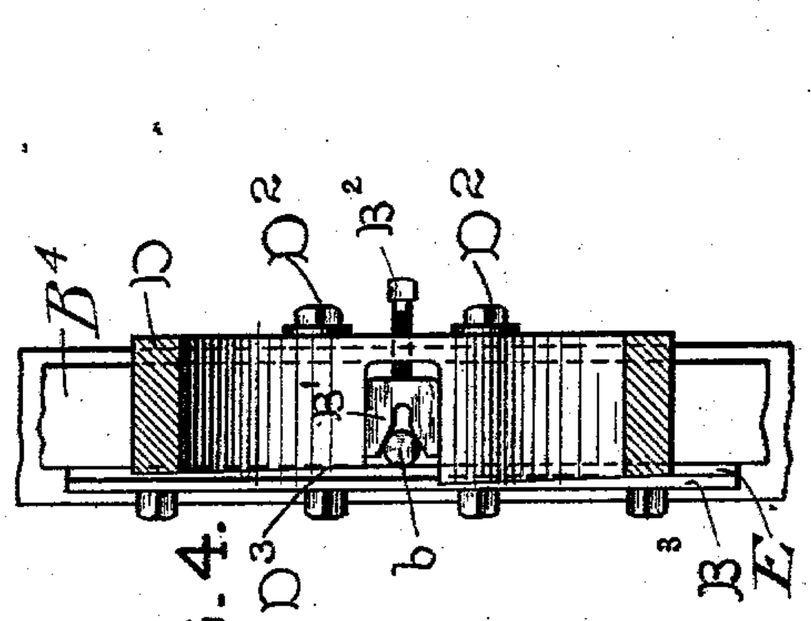

FIG. 4.

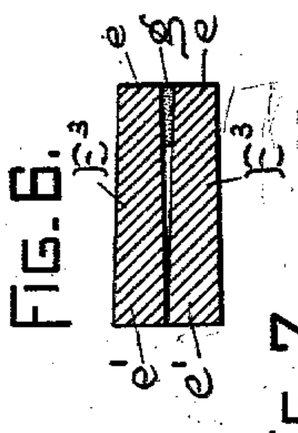

FIG. 6.

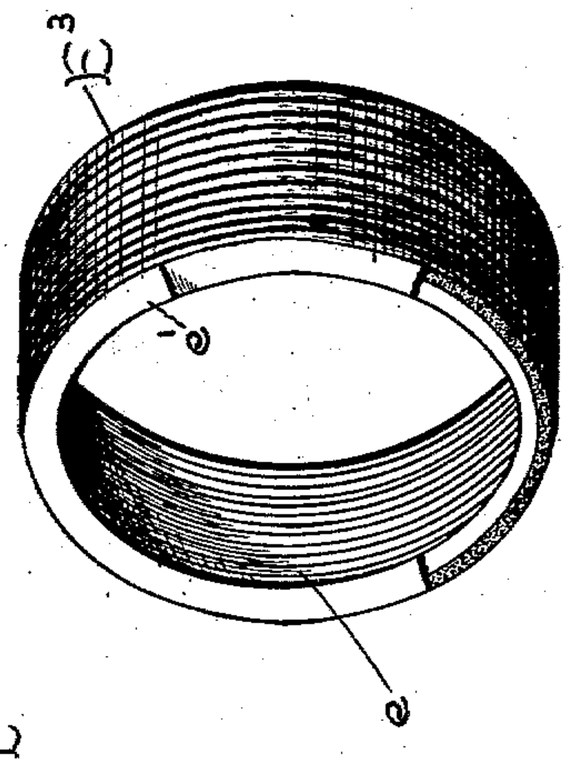

FIG. 7.

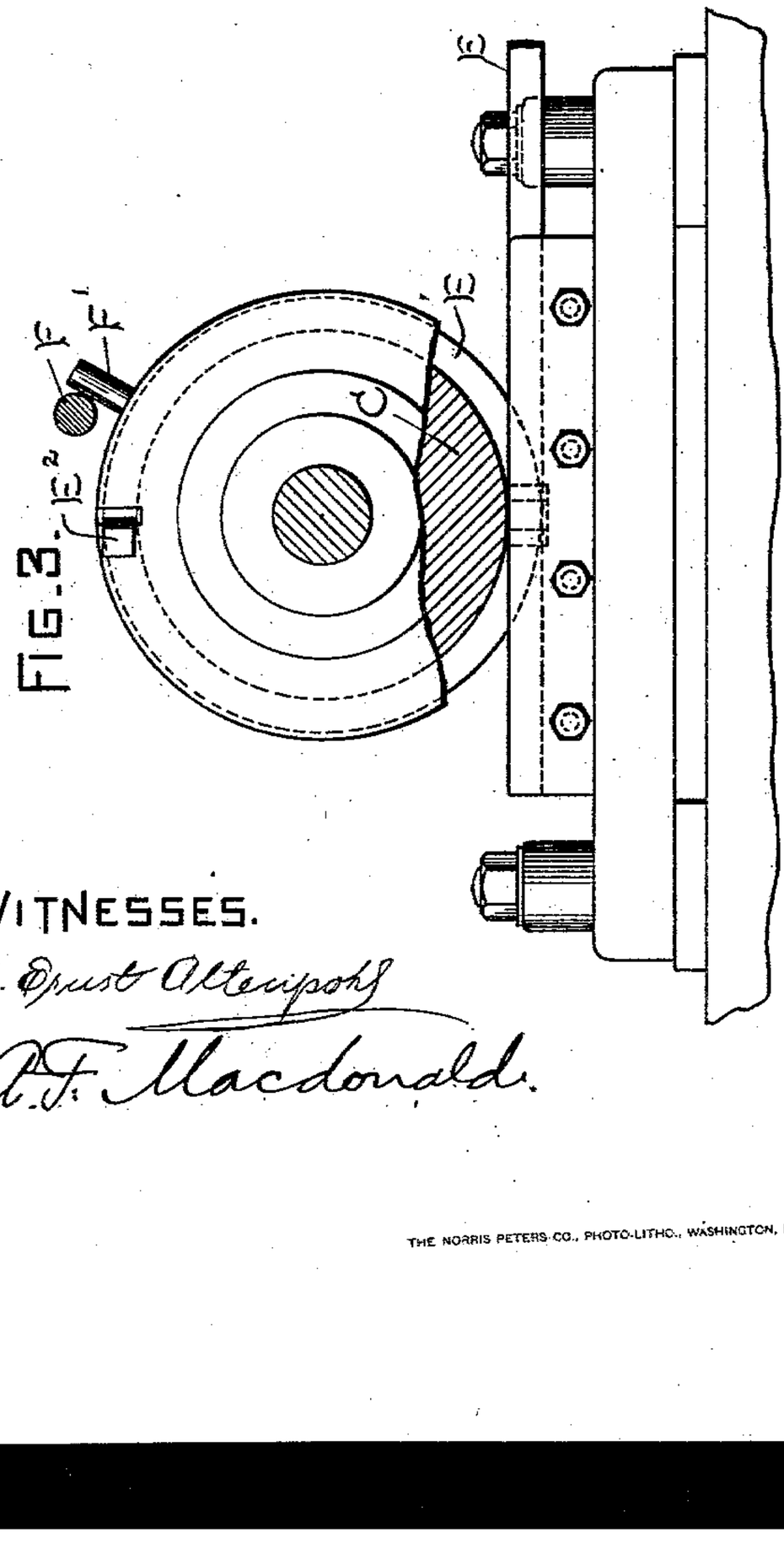

FIG. 3.

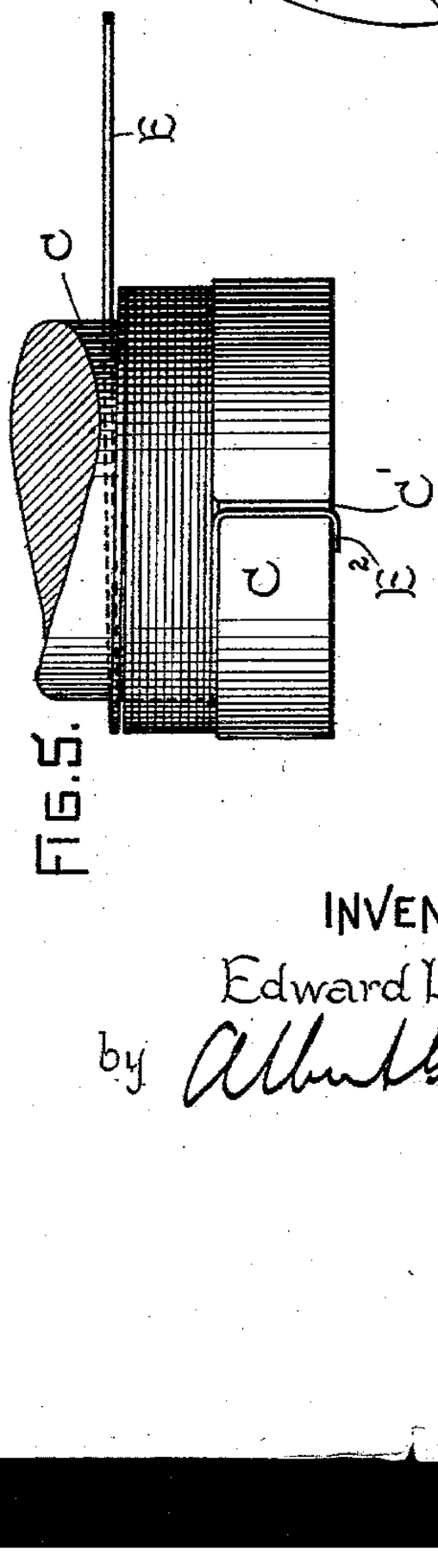

FIG. 5.

WITNESSES.

A. Ernst Altenpohl

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No. 744,018. PATENTED NOV. 17, 1903.

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APPLICATION FILED DEC. 5, 1898. NO MODEL. 3 SHEETS—SHEET 3.

FIG. 8.

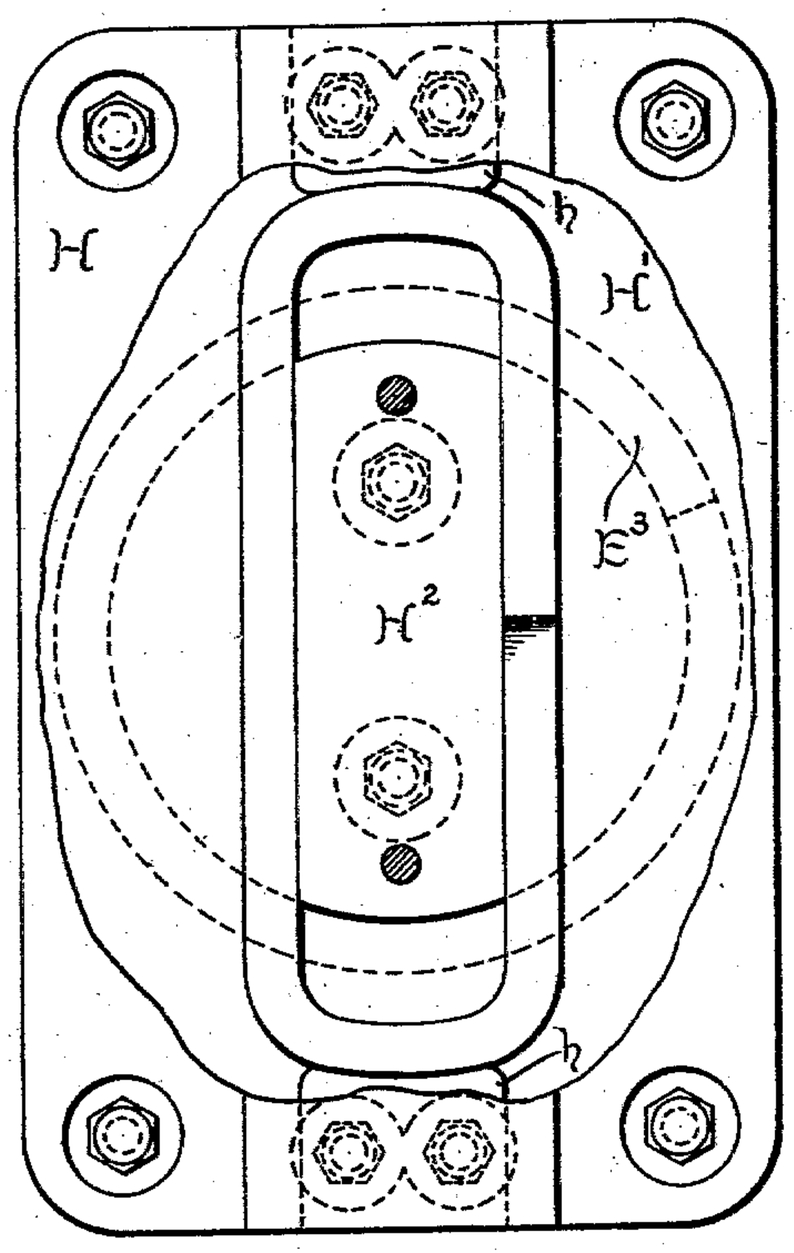

FIG. 10.

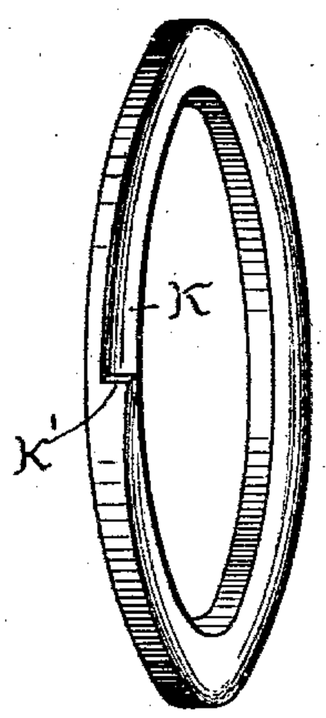

FIG. 9.

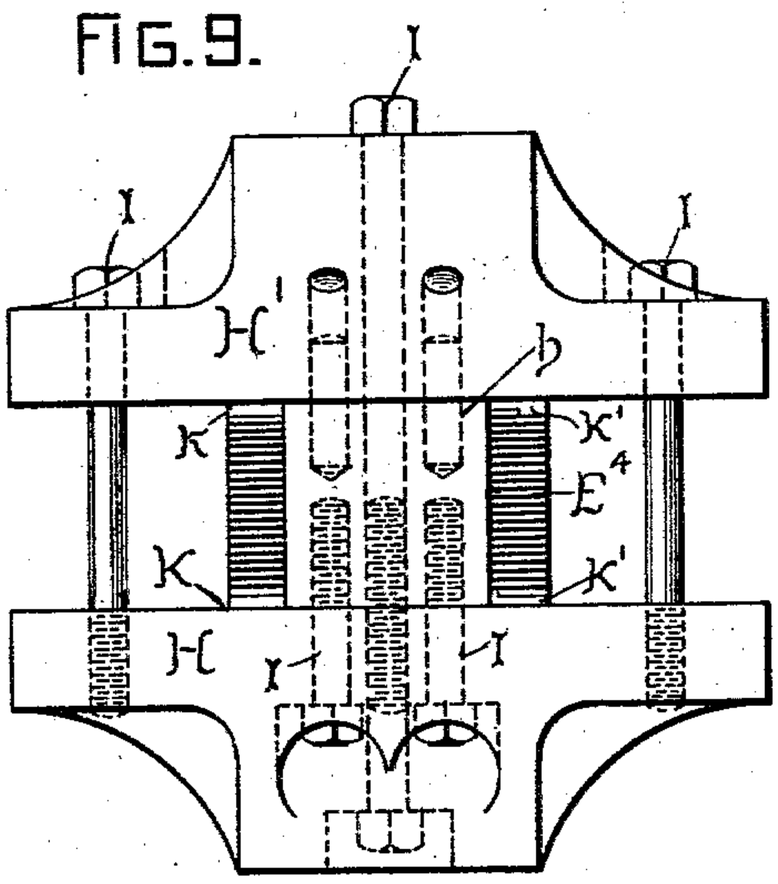

FIG. 11.

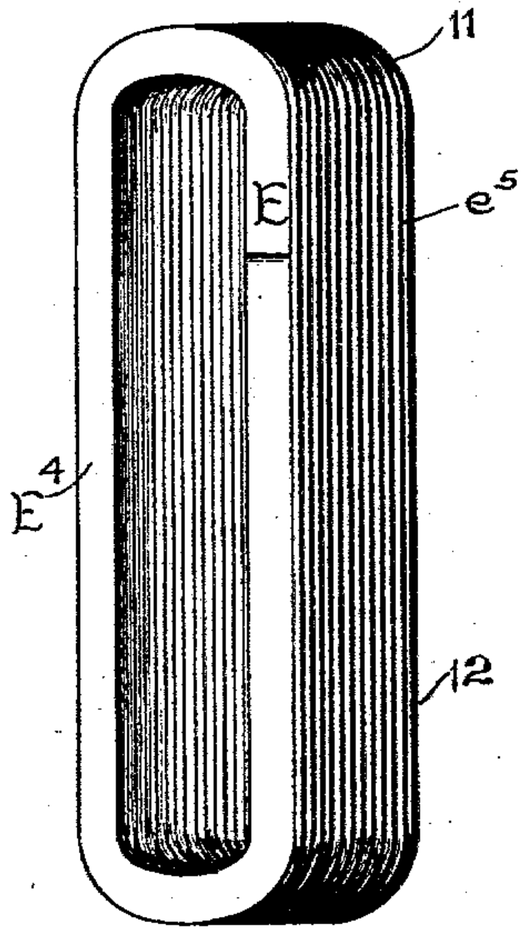

FIG. 11a.

FIG. 11b.

WITNESSES.

C. Ernst Allenspoth

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No. 744,018. Patented November 17, 1903.

UNITED STATES PATENT OFFICE.

EDWARD L. AIKEN, OF SCHENECTADY, NEW YORK, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

METHOD OF FORMING COILS FOR ELECTRICAL APPARATUS.

SPECIFICATION forming part of Letters Patent No. 744,018, dated November 17, 1903.

Application filed December 5, 1898. Serial No. 698,243. (No model.)

To all whom it may concern:

Be it known that I, EDWARD L. AIKEN, a citizen of the United States, residing at Schenectady, in the county of Schenectady and State of New York, have invented certain new and useful Improvements in Methods of Forming Coils for Electrical Apparatus, of which the following is a specification.

My present invention relates to a novel form of coil for magnetic pole-pieces and to the method of manufacturing the same.

As is well known, the preferred and usual method of providing magnetic pole-pieces with the required ampere-turns has been heretofore to wind the cores of such pole-pieces with a large number of convolutions of round wire covered with fibrous insulation and excite said pole-pieces by a relatively small electric current. The space occupied by the fibrous insulation and the space left unoccupied between individual convolutions is so considerable as to render the pole-pieces very bulky, and, moreover, prevents the radiation of heat from the cores.

The object of my invention is to provide such pole-pieces with conducting-coils, in which flat non-fibrous insulation, such as mica, is used between the contiguous sides of the convolutions, and wherein the metal of such conductors extends uninterrupted from the cores to the outside of the coils, whereby a metallic conduction of the heat from the cores is provided.

My invention consists in a coil made by bending a relatively wide and thin strip of conducting material edgewise into a helix without reduction of cross-sectional area and in the method of making said coils.

The particular means which I employ for carrying out the method in the manufacture of my improved coils is illustrated in the accompanying drawings, and in which—

Figure 1 represents an engine-lathe of ordinary construction with a coil in process of winding thereon. Fig. 2 is a side elevation, partly in section, of a part of the device shown in Fig. 1, here drawn upon an enlarged scale. Fig. 3 is an end elevation, partly in section, of the parts shown in Fig. 2, taken on the line 3 3. Fig. 4 is a plan, partly in section, of the arrangement shown in Figs. 2 and 3 for confining the strip while it is being wound. Fig. 5 is a plan of a part of the mandrel, with a coil partly wound thereon. Fig. 6 is a section of two turns of the coil, drawn upon an enlarged scale and showing the coil just after leaving the mandrel. Fig. 7 is a perspective of the coil, partly broken away, as it is taken from the mandrel. Fig. 8 is a plan, partly broken away, of the die in which the coil is pressed into shape. Fig. 9 is an end elevation of the parts shown in Fig. 8. Fig. 10 is a perspective of the end plate shaped to fit the coil, so that the latter will not be distorted in the press. Fig. 11 is a perspective of the completed coil. Fig. 11^a is a section of a single turn of the conductor at the point marked 11 in Fig. 11. Fig. 11^b is a similar section at the point marked 12.

In Fig. 1, A is the bed of a lathe, boring-mill, or other rotating mechanical structure. Of course any one of these devices may be used, as convenience may dictate, the essential feature being that it shall have sufficient power to turn the mandrel against the tension of the conductor being wound. B is the usual slide-rest, which may be fed by hand, if desired, but is ordinarily pushed along the slideways by the pressure of the work against the guide carried by the slide-rest. C is the mandrel, the construction of which will be best understood from Fig. 2. The other parts of the lathe are not referred to specifically by letter, inasmuch as their construction is well known and readily apparent. E is the conductor, which is to be wound from the reel E′.

As shown in Fig. 2, C is a mandrel which rotates between the centers X X by any suitable means, such as the pins F F′, connected with the face-plate of the lathe. As shown in Fig. 5, the face of the enlarged shoulder of the mandrel C is shaped as a helicoid. In this figure also is shown a slot C′ in the shoulder, into which the bent end E^2 of the strip E is inserted to secure that end to the mandrel.

In Figs. 2 and 4, D is a non-rotatable ring secured to move with the slide-rest B, having a working fit with the mandrel C and adapted to slide longitudinally thereof, whereby said

ring occupies positions successively farther removed from the shoulder of the mandrel C, so that the increasing coil of the strip E on the mandrel C is clamped between the shoulder of the mandrel and the ring D to assist in preventing buckling of the strip. The ring D is secured to the slide-rest B in the following manner: As shown in Fig. 2, the base-block B^4 is carried by the slide-rest, which block extends at a tangent to the surface of the mandrel C and forms a joint with the ring D by the ring being cut away for a portion of its width along the line of a chord tangent to the inner circumference of the ring, thus forming a flat surface which rests on the block B^4. The entire width of the ring D is not, however, cut away in this manner, but only as far as the right-hand edge of the block B^4, as shown by the inner dotted line in Fig. 4, thus leaving a depending arc or lip D′, Fig. 2, which extends along the side of the block B^4. The ring D is secured to the block B^4 by bolts D^2, Figs. 2 and 4, which pass through the lip D′ into the part B^4. Other bolts (not shown) may pass up through the block B^4 and into the ring D at the lower flat cut-away surface thereof. The ring D is formed with a helicoidal face opposing the similarly-shaped face of the shoulder of the mandrel C, and the strip E passes between these two surfaces and is wound on the mandrel. The block B^4 and the ring D are cut away, as shown in Figs. 2 and 4, to provide a space for the block B′, which is adjusted by means of a screw B^2, passing through the lip D′ of the ring, to force a rod or roller *b*, which acts as an antifriction device, against the strip E, which passes between the roller *b* and a guide B^3, bolted to the block B^4. The strip-coil on the mandrel presses against the guide B^3 and is securely held from buckling between the end of the wound coil and said guide B^3. The rod or roller *b* or its equivalent is a very important feature of the machine, as without some such means it would be practically impossible to initially bend a strip so thin without buckling or crimping, the thickness of said strip being only a sixth or less of the width.

Referring to Figs. 3 and 4, the operation may be described as follows: The strip E enters from the right between the ring D and the guide B^3 and passes beneath innermost projection of the helicoidal surface of the ring, which overhangs the strip and the guide B^3, as shown in Fig. 4. The strip then passes in contact with the roller and is forced by the helicoidal surface of the ring to assume the form of a helix surrounding the mandrel C. The slide-rest B, which carries the part B^4 and the ring D, is free to slide parallel to the axis of the mandrel C under the pressure of the strip E as it is being coiled.

Fig. 7 shows the coil when it is removed from the mandrel. At this time it is cylindrical, and the section of the layers is as shown in Fig. 6, each layer being marked E^3. The inner edge *e′* is shown thicker than the outer edge *e*, and between each layer of the coil on the outer edge is placed a strip *g*, which may be of any desired material, but usually is of thick paper, the same being removed before the final insulation e^5 is inserted. This is done to keep the several convolutions of the coil in position and in approximately cylindrical shape for the press.

In Figs. 8 and 9, H H′ are the sides of the form or die in which the coil is pressed into its final shape. The dotted circle E^3 represents the cylindrical coil as it is when first put in the press. A block H^2 just fits at its ends the inner periphery of the uncompressed coil, and outer blocks *h h* at each end have faces curved to fit the final shape of the ends of the coil.

As it is manifest that the coil as shown in Fig. 7 will have each end projecting beyond the helix by an amount equal to the thickness of the strip, so that if it were pressed firmly together in this shape the ends would be distorted, I prepare rings K, such as are shown in Fig. 10, the inner surface of each of which is turned to a helix having a shoulder K′, against which the end of the coil rests. When one of these is placed upon each end of the coil, the whole becomes a cylinder with plane ends, and in this shape it is inserted in the press. New rings are of course necessary for each coil, as it is manifest that at each operation they are distorted to the shape of the coil as it leaves the die. After the parts of the die are secured in place by the bolts I I pressure is applied to the sides of the coil in any convenient manner, and it is brought to the shape shown in Fig. 11. The ends of the coil are left, as will be apparent from Fig. 8, free to move out from the block H^2 until they bear against the curved blocks *h h*, and as the sides E^4 of the coil (see Fig. 11) are brought from the shape shown in Fig. 7 the thickened inner edge stretches until the strip at this part of the coil becomes of substantially the same thickness throughout, as shown in Fig. 11^b, while as the ends bearing against the blocks *h h* are not stretched so much they retain to a great extent the trapezoidal cross-section shown in Fig. 11^a. After the coil is removed from the press the paper spacing-strips are removed from between the convolutions and permanent insulation e^5 inserted. This insulation may be of any of the well-known materials adapted for that purpose, such as mica, rubber prepared fiber, and the like.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The method which consists in winding a strip of uniform thin cross-section into a cylindrical helical coil wherein the surfaces of the strip are substantially perpendicular to the axis of the coil, and the inner edge of the strip is thicker than the outer edge, and then

compressing the sides of the coil so that it assumes an oblong shape with curved ends, wherein the inner edges of the coil have been stretched.

2. The method which consists in winding a strip of relatively wide and thin cross-section into a helical coil wherein the flat surfaces of the strip are substantially perpendicular to the axis of the coil and thereafter shaping said helical coil into the desired contour.

In witness whereof I have hereunto set my hand this 3d day of December, 1898.

EDWARD L. AIKEN.

Witnesses:
B. B. HULL,
A. D. LUNT.