(No Model.) 8 Sheets—Sheet 1.

B. G. LAMME.

ARMATURE FOR ELECTRIC MACHINES.

No. 488,016. Patented Dec. 13, 1892.

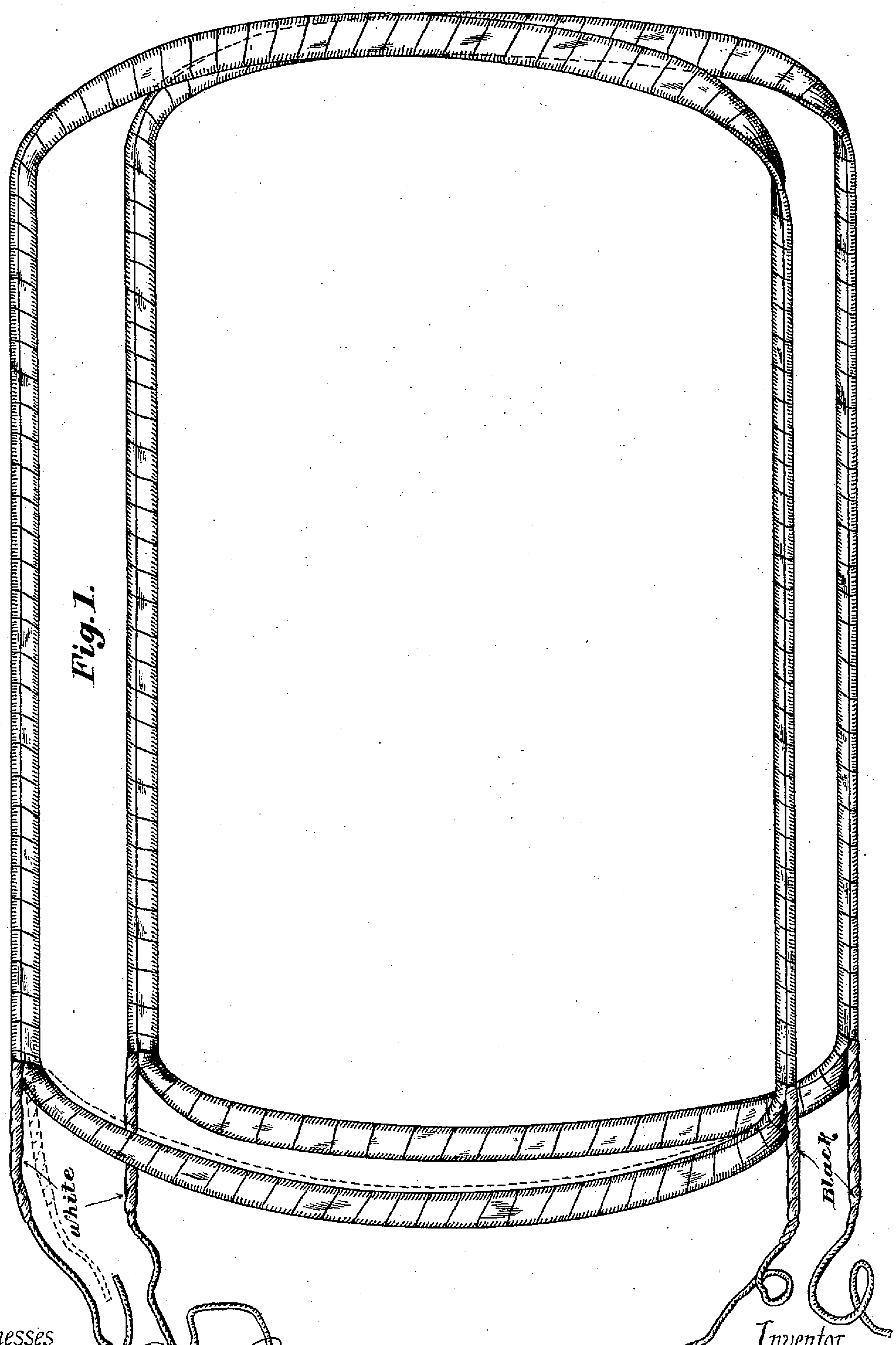

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Fig. 2.

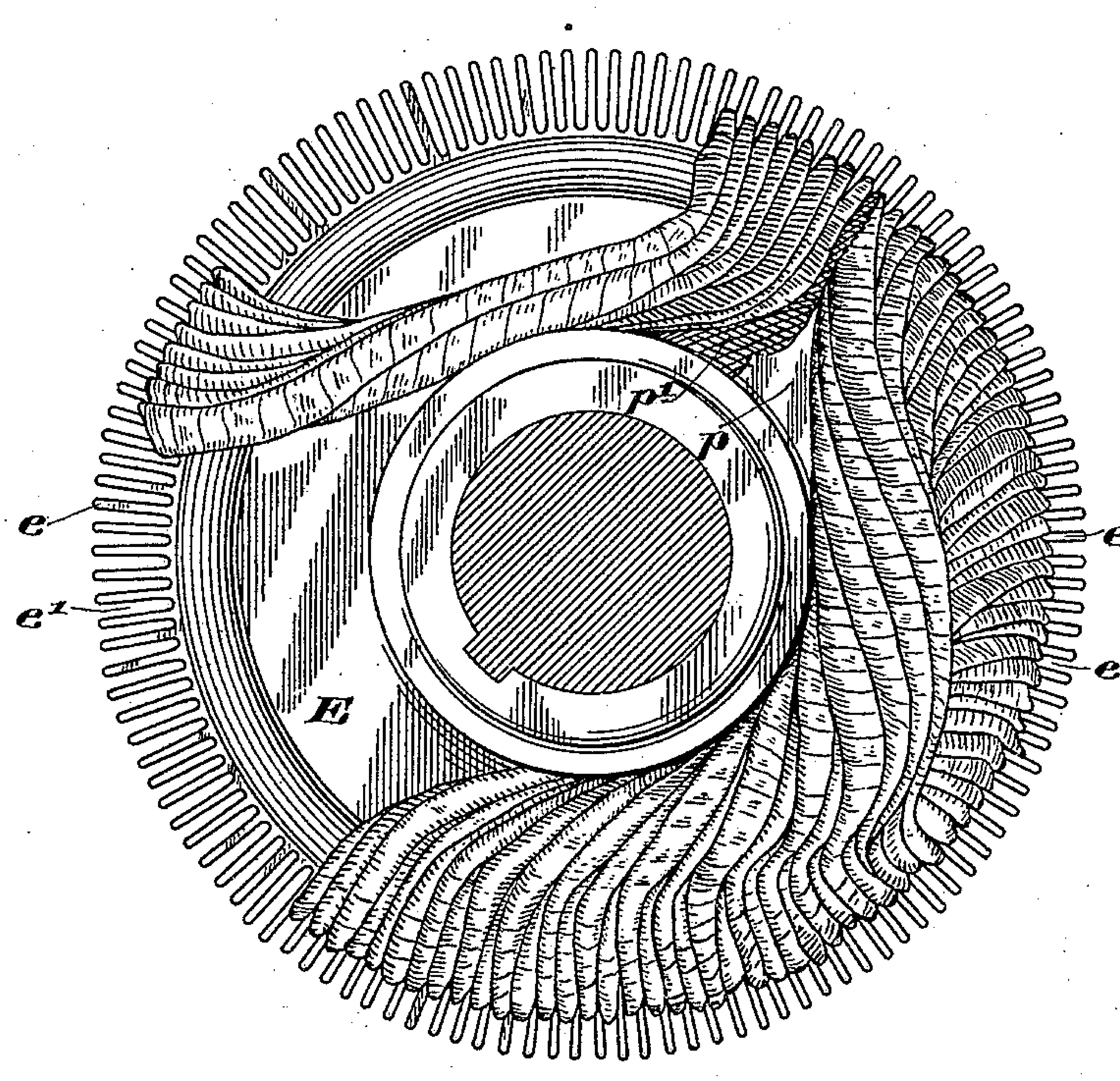

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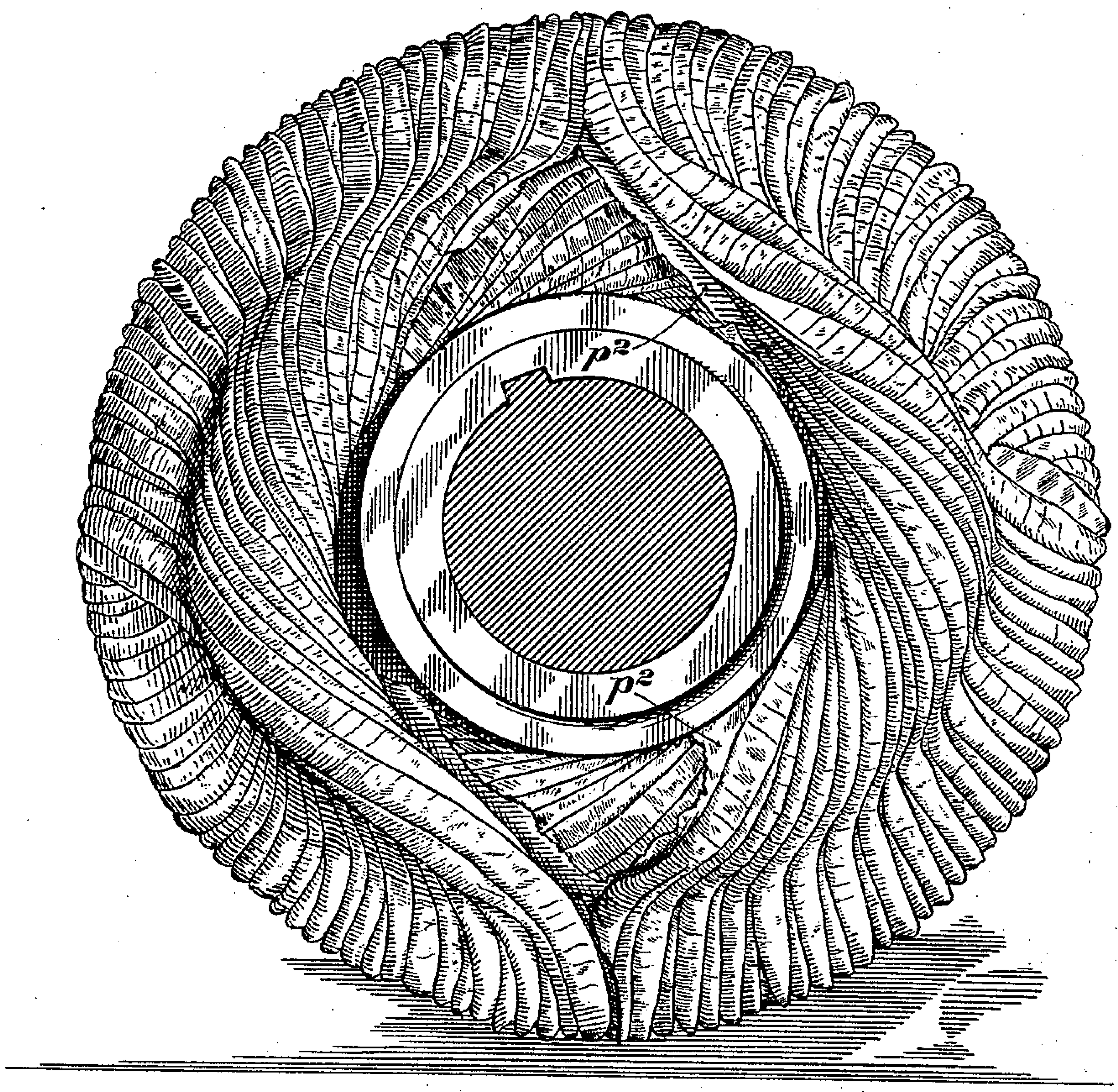
Fig.3.



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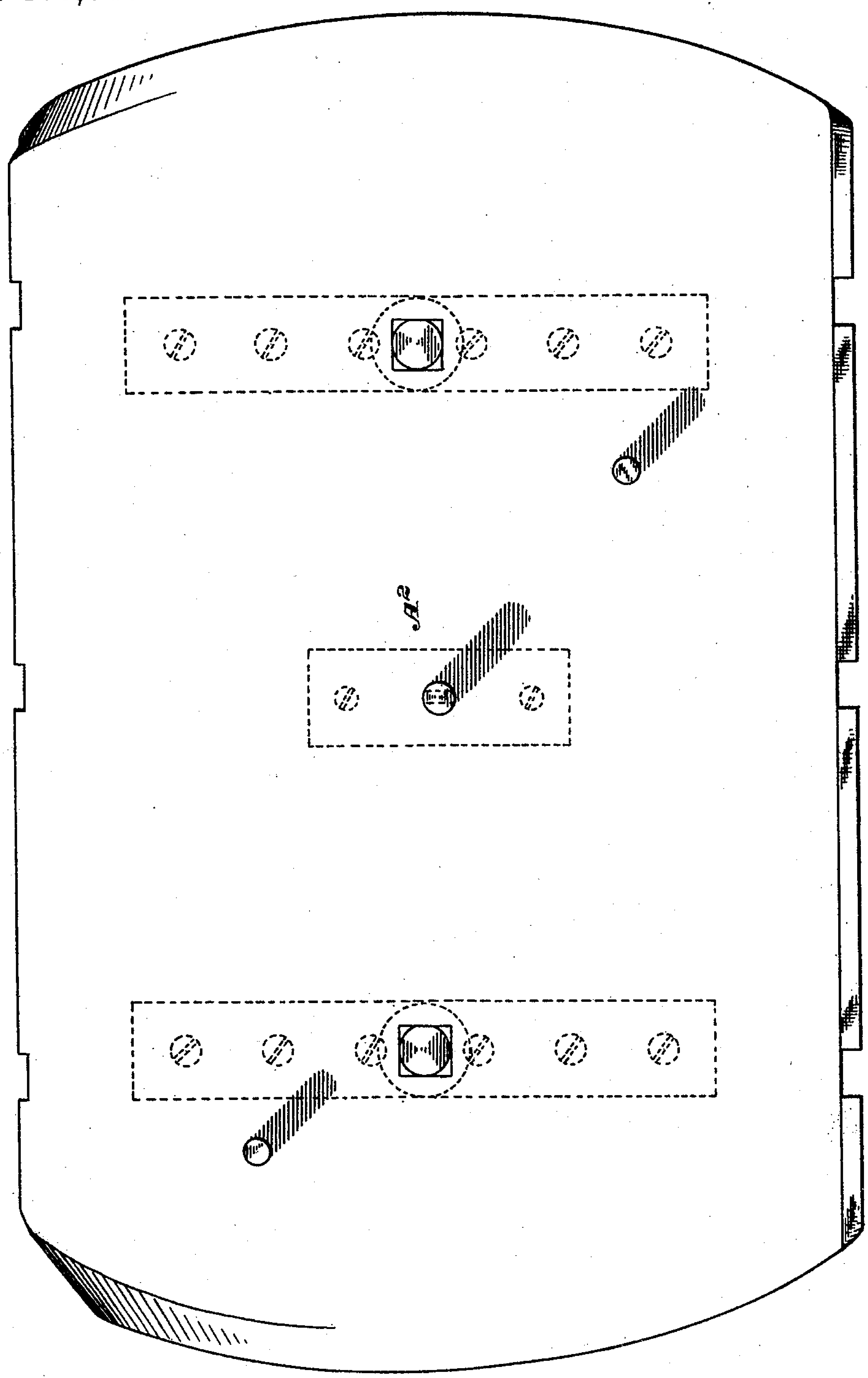

Fig. 4.

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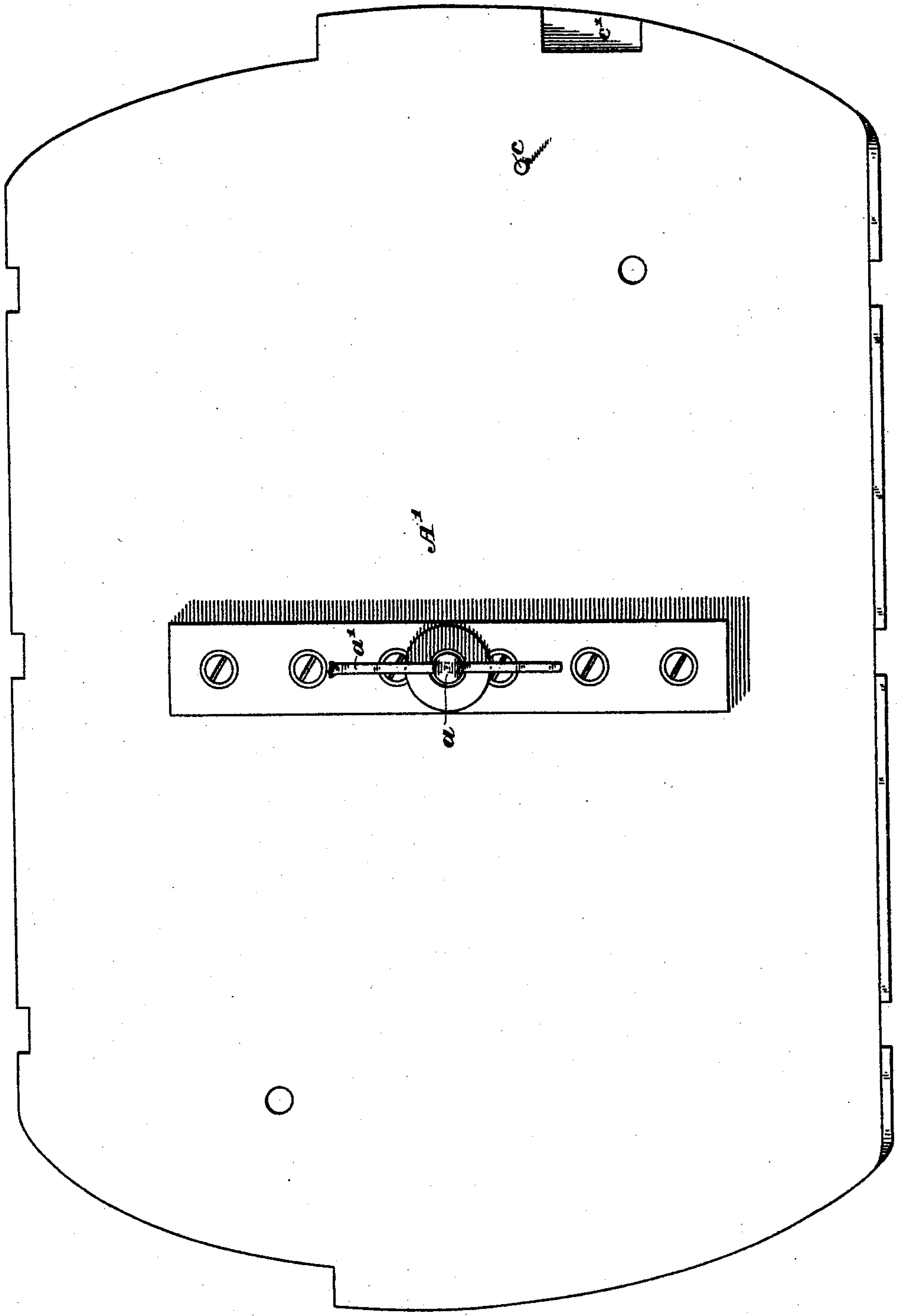
Fig. 5.



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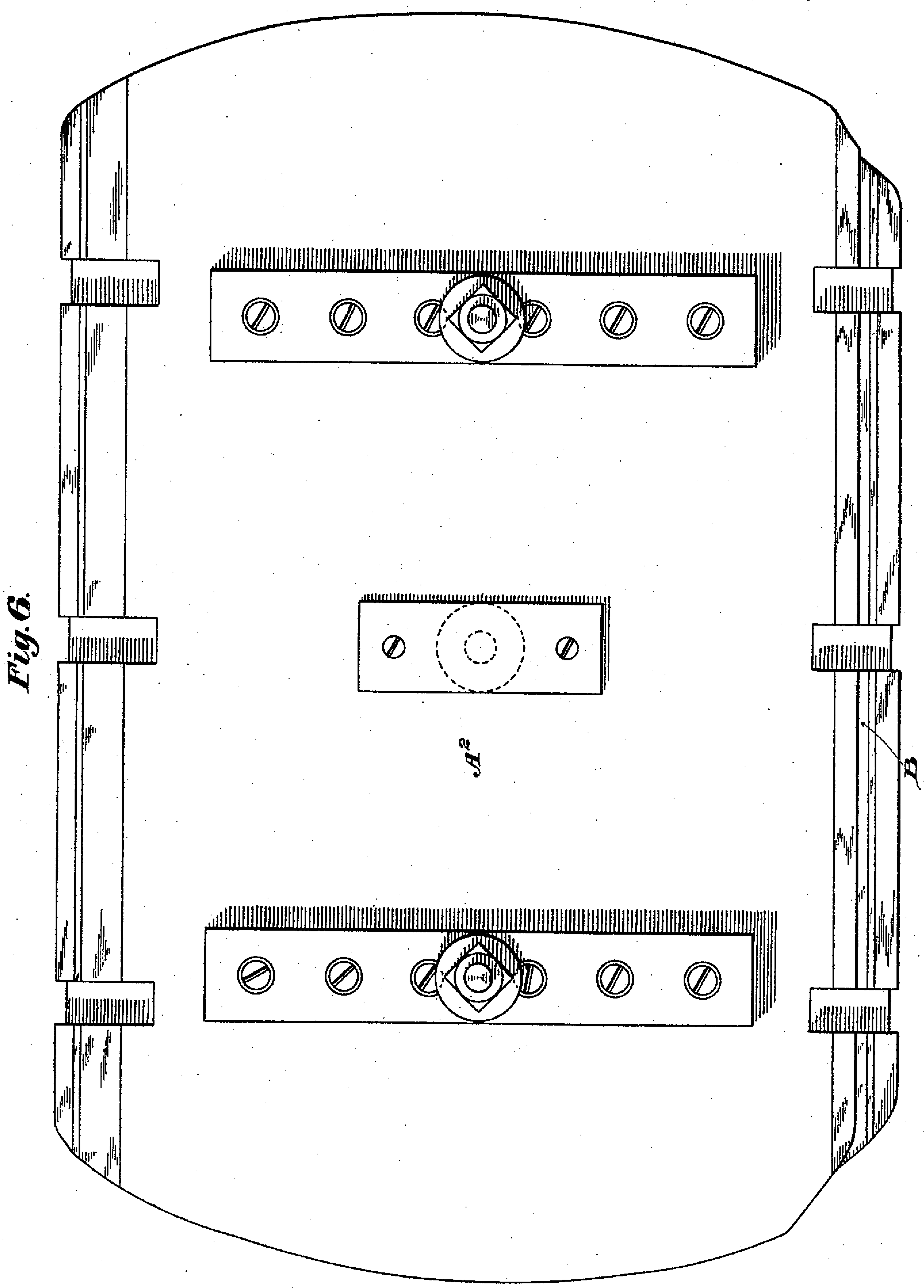

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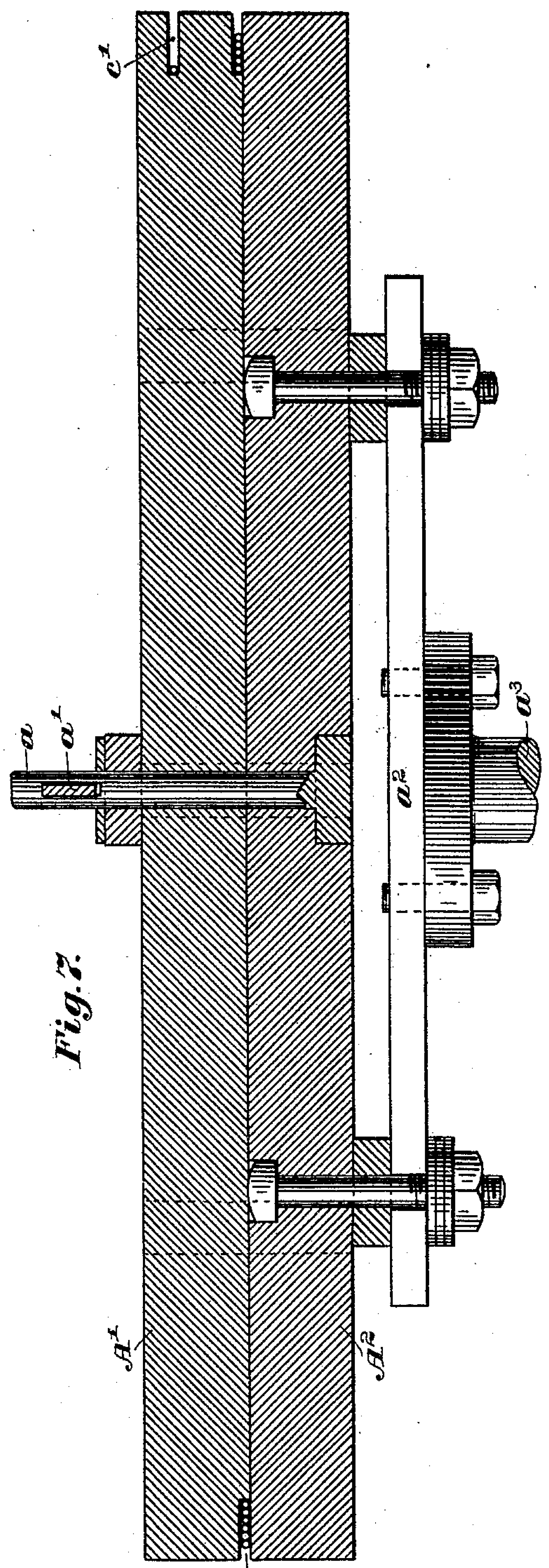

Fig. 7.

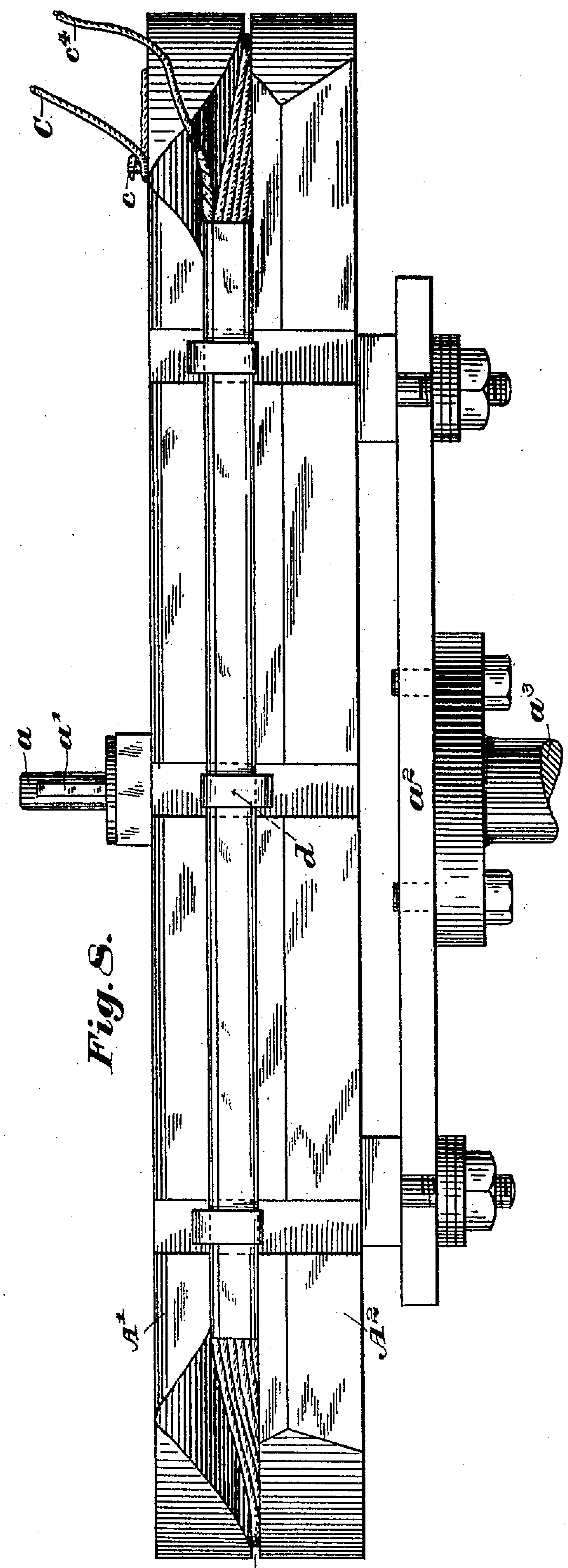

Fig. 8.

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(No Model.) 8 Sheets—Sheet 8.

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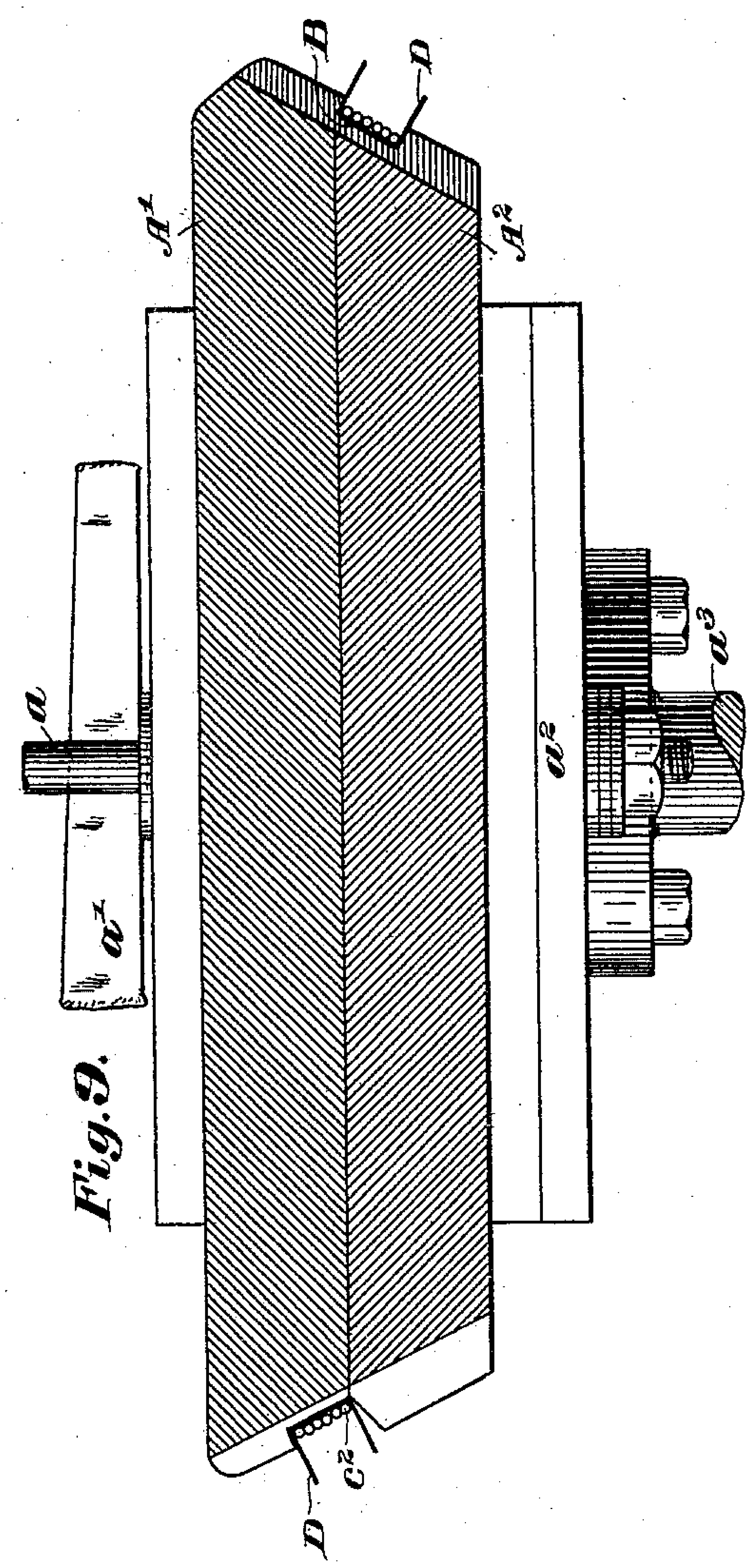

Fig. 9.

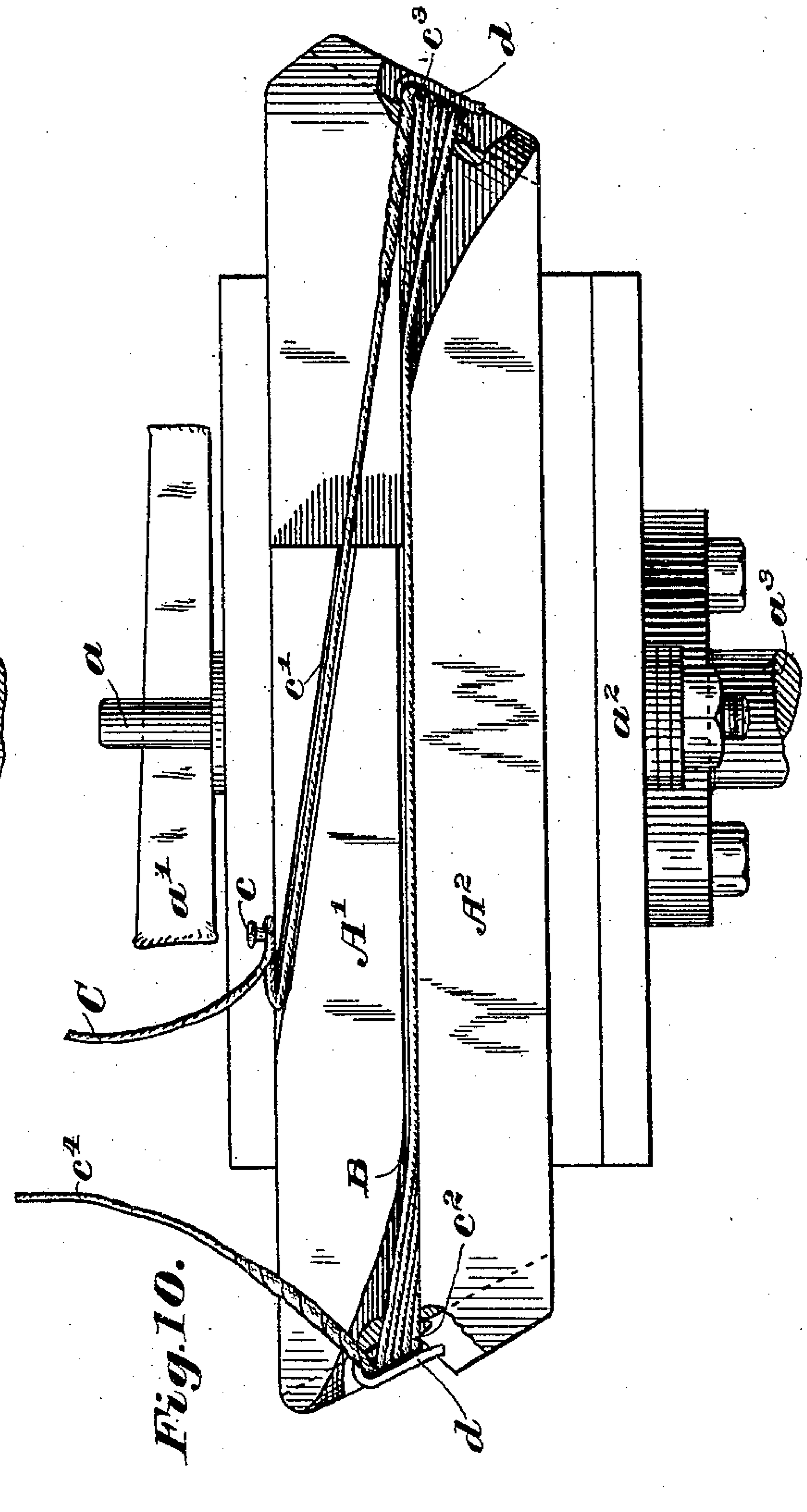

Fig. 10.

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UNITED STATES PATENT OFFICE.

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ARMATURE FOR ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 488,016, dated December 13, 1892.

Application filed February 8, 1892. Serial No. 420,741. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN G. LAMME, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Armatures for Electric Machines and in the Method of Constructing the Same, (Case No. 485,) of which the following is a specification.

The invention relates to the construction of the armatures of electric machines, and particularly to the method of forming and applying the coils to the armature-cores.

Armatures for electric machines have heretofore been built in various different ways. For instance, they have been constructed with radiating teeth, between which are wound coils or bobbins of insulated wire, the convolutions of the bobbins being wound into the spaces between the teeth. In other instances the armature-cores have been constructed with a smooth exterior surface, and coils which have been previously wound have been laid upon this surface. In still other instances previously-wound coils have been placed over individual projecting teeth of the armature-cores and pressed into place beneath the projections of the teeth. The present invention differs from any of the plans above referred to and may be said to consist generally in forming an armature-core with numerous radiating teeth and placing previously wound and insulated coils in the spaces between the teeth, each coil spanning several teeth, and in bending the ends of the coils down against the ends of the armature-core and of underlying coils. In practice it is frequently desirable to place two of such previously wound and insulated coils in each pair of grooves or spaces between the teeth, first placing in one set and then bending their ends down and afterward superposing the others. In practice it is usually found convenient to bend down the ends of each coil immediately upon its insertion—that is to say, each coil is fitted to the armature and placed in final position in succession.

In the accompanying drawings, Figure 1 shows two armature-coils which have been separately wound and insulated, the two coils being suited, respectively, for the first and second layers where two sets are employed. Fig. 2 is an end view of a toothed armature-core with some of the coils applied. Fig. 3 is an end view of the armature after all the coils have been applied. Figs. 4 and 5 are plans of the respective sections of a block or coil-mold in which the coils are originally formed. Fig. 6 is an elevation of the two sections in position for receiving a coil. Fig. 7 is a longitudinal section, and Fig. 8 is a side elevation, of the block with coils applied. Fig. 9 is a cross-section, and Fig. 10 an end view, of the block with coils wound thereon.

Referring to the figures, a description will first be given of the plan of winding or forming the coils. The forming-block is made in two parts A′ A². These two blocks are bolted together or suitably fastened in any convenient manner—as, for instance, by a bolt a, passing through from one block to the other and keyed, as indicated at a'. A plate a^2 may be securely fastened to one of the plates A², and this plate is provided with a stem a^3, by means of which it may be held in a lathe or supported in any suitable manner for convenience in winding. By placing the stem in the lathe the mold may be revolved and the wire laid into the suitable receiving-groove B, which extends around the periphery of the mold. The general shape and form of the groove is illustrated in the drawings. It may be generally stated of it that it is narrow and deep at the two ends of the mold and at the two sides it is shallow and of a width approximately equivalent to the depth upon the two ends. Moreover, the groove is further so formed that a twist is given to it at each end, so that the strand of wire which is toward the left hand upon one side of the mold falls upon the right hand upon the other side of the mold. This construction provides that the two terminals of a coil when placed upon the armature will both be upon the outer side instead of one of them being at the bottom of the groove or space within which it is laid.

In using the mold after it has been suitably placed together and mounted upon a lathe two sockets of insulating material—such, for instance, as fuller-boards, which have been previously bent into a **U** shape, as illustrated at D—are laid in the grooves in the opposite sides of the mold. The sides of these sockets project outward a sufficient distance to permit of their being bent down over the coils after the wires have been laid therein. One end of a wire C is then fastened to a pin c and passed along a groove c' until it reaches the edge of the mold. It is then laid against the bottom of the insulating-plate toward the left hand, Fig. 10. The mold is revolved and the wire is laid along the length and across the end and then appears upon the opposite edge of the opposite side of the mold in the position indicated by the strand marked c^2, Figs. 9 and 10. This strand is then passed along the end of the mold and lies at the bottom of the groove until it reaches the first side of the mold, where it appears in the position indicated by the strand c^3, Fig. 10. The wire is continuously applied in the manner above described until the final end appears in the position marked c^4. This construction introduces a half-turn in the coil at each end. The sides of the insulating-sockets are then turned down upon the surface of the wire and glued in position, and temporary clamps d may be employed for holding them in position until dried. The key a' is then removed, the blocks separated, and the coil is slipped off from the mold. It should be observed that the left-hand edge—that is to say, the first edge formed on one side of the coil—is approximately in the same plane as the right-hand edge of the opposite side of the coil. This clearly appears in Fig. 9—that is to say, the two sides of the coil will fall upon opposite sides of a plane which is made perpendicular to the axis of the coil. Furthermore, the two sides converge at an angle which would cause planes projected in the direction of the planes of the sides of the coils to meet at a distance from the coils approximately equal to the radius of the armature-core to which they are to be applied. In this way the coils are in proper form to be readily fitted between the armature-teeth. After the coils have been suitably wound the respective ends are taped, as indicated in the drawings, and for convenience in using the coils it is found desirable to tape them with different-colored tapes, so that corresponding ends may always be distinguished. The coils may then be immersed in a suitable insulating material, such as varnish or shellac, and afterward the entire coil is thoroughly taped, as indicated in Figs. 1 and 2. They are then ready to be applied to the armature-core.

The armature-core E is made with narrow radiating teeth e, leaving intervening spaces e'. This core may be of any suitable character and may with advantage be made of thin plates built up in a manner well understood. The coils, having been prepared in the manner described, are pressed into the grooves e', the two sides spanning a predetermined number of teeth. The ends are then pressed down against the ends of the armature-core and successive coils are fitted against each other in the general manner illustrated in Figs. 2 and 3. By this system each coil is fitted to its place as it is put on and will not fit in another position without slightly-different bends at the end. In other words, all coils are first made in one general shape and each coil is fitted to the armature when placed in position and its ends bent to conform to the most convenient position against the underlying coils.

The twist or half-turn in the ends of the coil is important, as it renders it possible to readily bend the ends of the coil down into place against the end of the armature. Several wires taped into an ordinary flat coil will not allow of much bending without "buckling" the coil. The twist in the present instance does away with this to a great extent. The strand of wire at the upper or outer edge of one side of a coil lies at the lower edge of the other side. The second wire from the top on one side is the second from the bottom on the other side, and so on. In bending down the coil over the end of the armature the wires, being of the same length approximately, adjust themselves to the bend by merely twisting the coil a little more or less and there is no sliding or shifting of wires upon each other. This twist also permits the ends of each coil to lie flat against the underlying coil, thus requiring less space at the end of the armature than if they stood out edgewise.

By reference to Fig. 2 it will be seen that the bending down of the ends of the coils produces two rolls or bunches at the end of the armature, an open space being left at each side between them, as shown at p, for instance. The only points in the armature where any considerable difference of potential occurs is where the two halves thus formed meet, and for additional security a layer of insulating material p' may be inserted between the two sections at these points. It should be added, however, that the armature is wound with as many sets or divisions of coils as there are poles to the armature. In a four-pole armature, for example, there will be four divisions of the armature-coils. This may be most conveniently accomplished by using two layers of coils, each layer arranged in two sections, two coils being placed in each set of spaces between the teeth. In order that the ends of the coils may suitably shape themselves at the ends of the armature-core when they are bent down, it is desirable that the outer shall be slightly longer than the inner ones, as they have to lap over the inner ones at the ends of the armature. When two layers of coils are thus employed, they are so applied that the two rolls formed at the ends by the outer coils are above the spaces between the two rolls formed by the inner coils, and as a result the ends of the armature present a neat uniform appearance and a mechanical balance and the end wires are not massed together, as in ordinary constructions, and this affords better ventilation.

For the purpose of thoroughly insulating the inner from the outer layer of coils a cap or sheet p^2 of insulating material may be placed over each end of the armature after the first layer is applied. By thus winding in sets, however, and in two layers wires having high difference of potential are not brought close together except at the points where the sets meet, and these points, as already stated, are specially insulated. The adjacent coils at the ends are connected with adjacent commutator-bars. The bending down and fitting of each coil in place gives it a shape which helps to hold it in its slots against centrifugal forces, thus making it possible to dispense with bands in certain cases. When the winding is finished, all the coils, except a few at the end of each upper set, are rigidly held in place in the rolls, thus preventing any vibration or movement among them. The last few coils may be fitted especially tightly in the slots, thus giving them the sufficient support. An armature constructed in this manner possesses several advantages over those in which the coils are wound upon the surface. Thus, for example, in a surface-wound armature subjected to great stress or torque the wires are liable to be shifted by reason of the strain exerted upon them, and if not shifted bodily they have a constant tendency to move slightly to and fro, thus producing an abrasion and an injury to the insulation.

By winding the coils in formers and insulating them thoroughly by the fuller-board and tape all danger of making accidental electrical connection with the core is avoided and the coils may be driven tightly into the spaces between the teeth, and thus held rigidly without danger of shifting or abrasion. This insulation cannot be obtained by winding the coils by hand into the spaces between the teeth. Neither can the result of bringing the two ends of the wire upon the outside be secured by laying the separate convolutions in the spaces in the armature-core, for the first end of the coil would lie at the bottom of one slot, while the last end would be at the outer edge of its slot. This is a matter of considerable importance in practical work, for if either end of the wire were at the bottom of the slot it would necessitate an additional bend in the strand of wire in order to bring it out to the commutator. The economy of construction, moreover, is another advantage of importance, the winding of the coils by machine or in formers being much less expensive than the construction which requries the laying of the individual wires into the openings between the teeth.

Instead of having the last end of the coil brought out at the opposite side from the first end it may be carried across into proximity to the first end, as indicated by dotted lines in Fig. 1. The position desirable in any given instance will depend upon the form and purpose of the armature in which the coil is to be used.

I claim as my invention—

1. The combination, with a drum-armature core having radiating teeth, of separately-wound coils placed within the spaces between the teeth, each coil spanning several teeth.

2. The combination, with a drum-armature core having radiating teeth, of coils of insulated wire placed within the spaces between the teeth, each coil spanning several teeth, said coils being separately wound and separately insulated.

3. The combination of a toothed armature-core and machine-wound coils placed in slots between the teeth of said core, each of which coils spans several of the teeth.

4. A coil for the armature of an electric machine, having its two sides lying in converging planes and its two ends each containing a half-turn, whereby the upper wire upon one side becomes the under wire upon the other side.

5. An armature for an electric machine, consisting of a toothed core and two series of coils placed within the spaces between the teeth, each coil of each of said series being separately wound and separately insulated.

6. An armature for electric machines, consisting of a toothed core, a series of insulated armature-coils laid in the spaces between the teeth and each coil spanning two or more teeth, and a second series of insulated coils laid in the spaces upon the first series.

7. An armature for electric machines, consisting of a toothed armature-core, a series of previously-wound armature-coils laid in spaces between teeth and each coil spanning several teeth and having its ends afterward bent down upon the ends of the armature-core, and a second series of previously-wound coils laid above the first-named and having their ends afterward bent down against the end of the armature-core and the underlying coils.

8. In an armature for electric machines, two sets of separately wound and insulated armature-coils, one set being placed radially over the other, the length of the coils of one set being greater than that of the coils of the other set.

9. An armature-coil consisting of convolutions of insulated wire and a longitudinal insulating-sheath applied to two sides of said coil.

10. The combination, with a toothed armature-core, of coils of wire laid through the teeth and pressed down upon the ends of the core, each coil binding in position the previous coils, substantially as described.

11. In an armature for electric machines, the combination, with a toothed armature-core, of previously wound and insulated coils laid within the spaces between the teeth and each coil spanning several teeth, the ends of

the coils being pressed down against the ends of the armature-core and forming two or more rolls or projections at each end of the core, substantially as described.

12. In an armature for electric machines, a toothed armature-core and two layers of armature-coils, each layer divided into sections, all of the coils having their ends pressed down toward the respective ends of the armature-core and the ends of each section forming a roll or projection, the rolls or projections formed by one layer of coils coming between the rolls or projections formed by the other layer of coils.

13. An armature-core for electric machines and previously wound and insulated coils applied thereto, said coils being pressed down against the ends of the armature-core at an angle to the portions lying across the face of the armature, the portions against the ends of the armature having their edges approximately perpendicular to the axis of rotation, substantially as described.

In testimony whereof I have hereunto subscribed my name this 5th day of February, A. D. 1892.

BENJAMIN G. LAMME.

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JAMES WM. SMITH.