No. 733,232. PATENTED JULY 7, 1903.

J. W. LUNDSKOG.

WINDING FORM.

APPLICATION FILED JUNE 21, 1901.

NO MODEL. 3 SHEETS—SHEET 1.

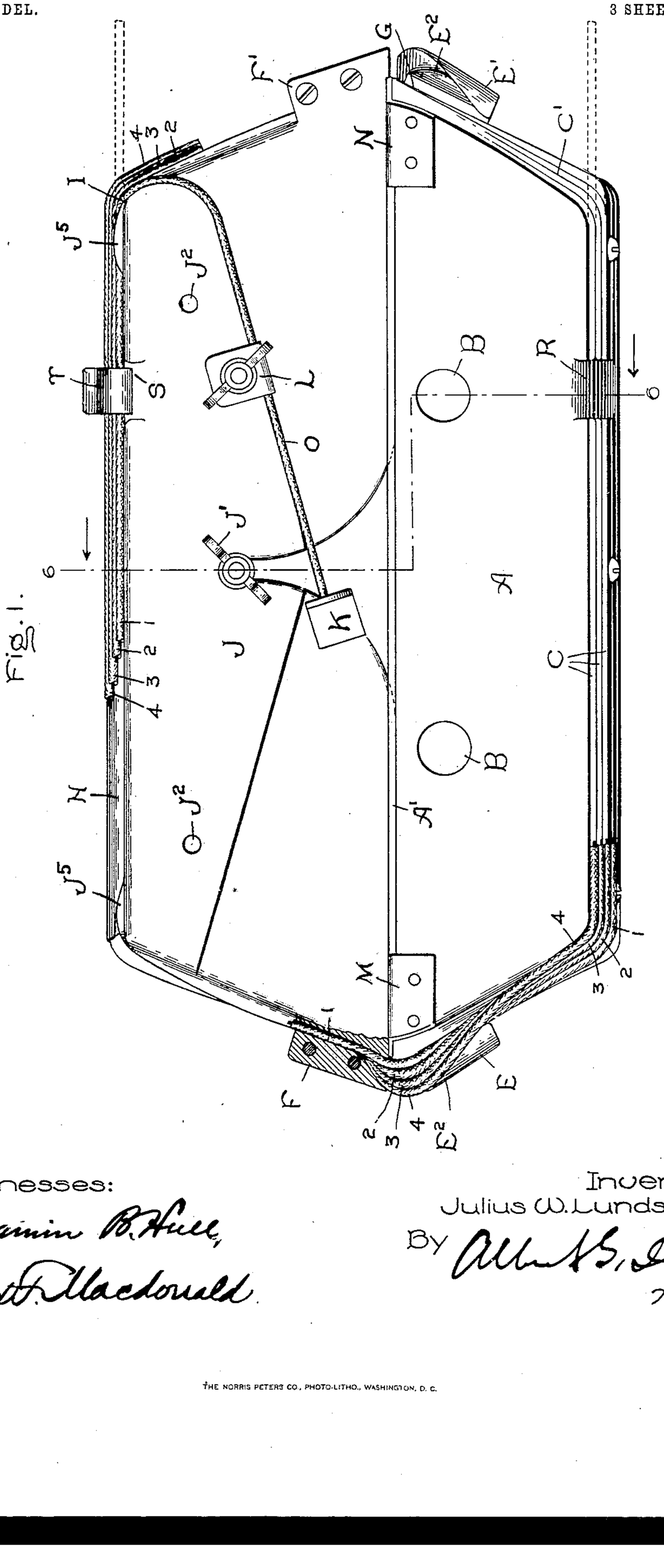

Fig. 1.

Witnesses:
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Alex. F. Macdonald.

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 3.

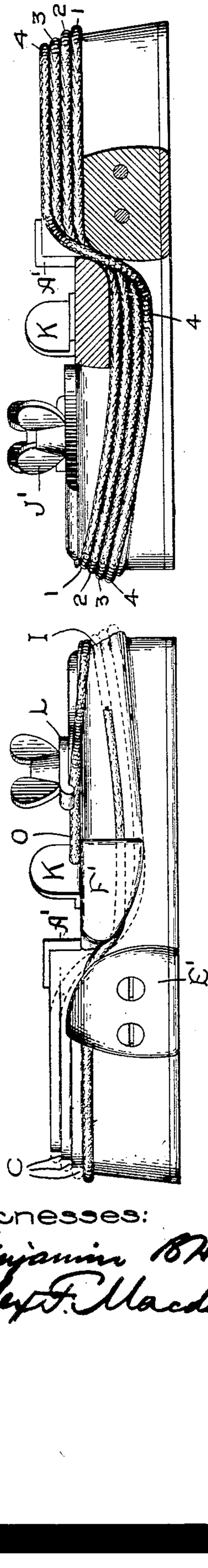

Fig. 4.

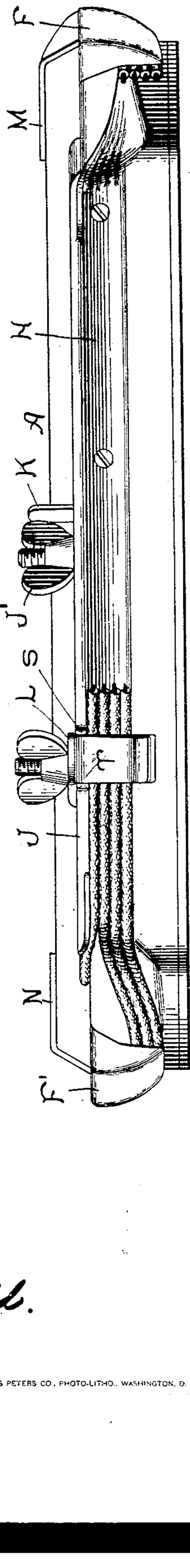

Fig. 5.

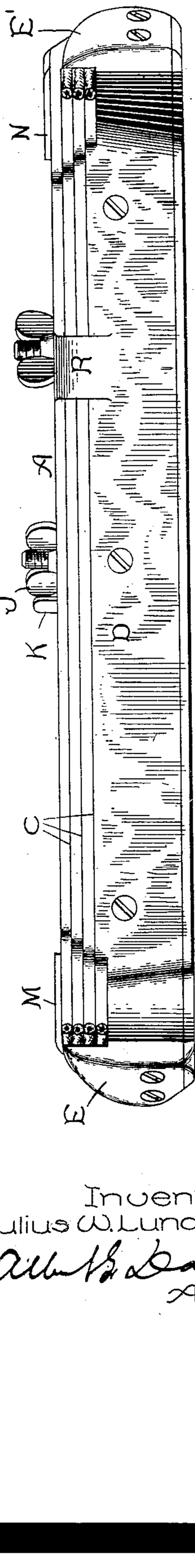

Fig. 2.

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APPLICATION FILED JUNE 21, 1901.

NO MODEL. 3 SHEETS—SHEET 3.

Fig. 6.

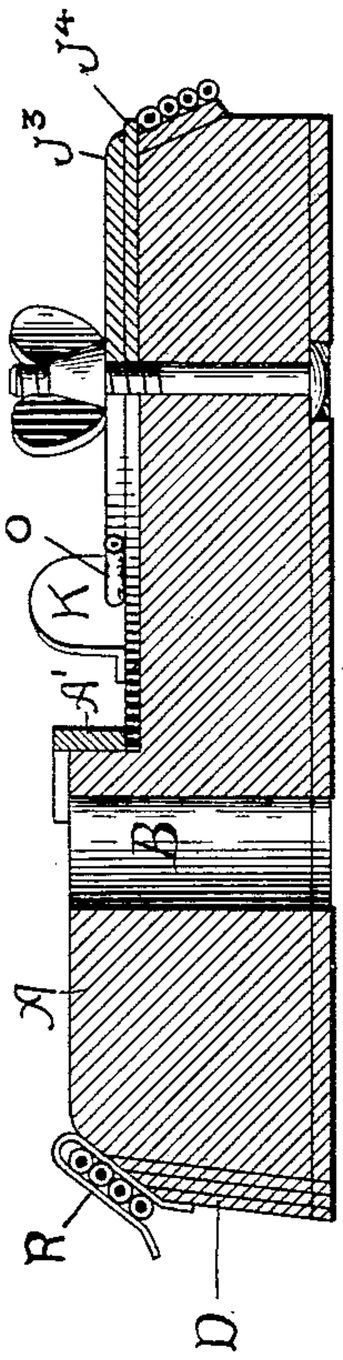


Fig. 7.

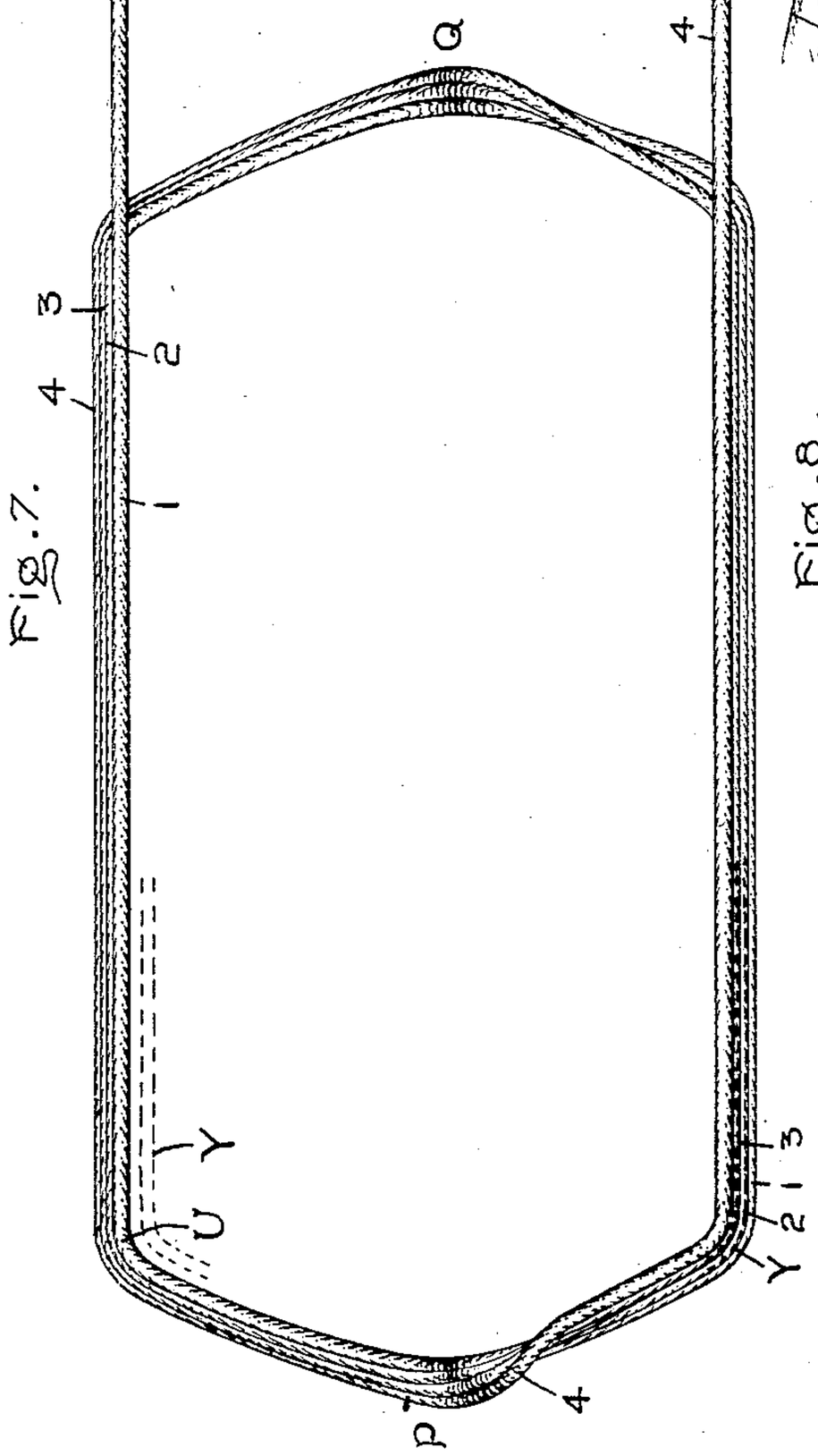


Fig. 9.

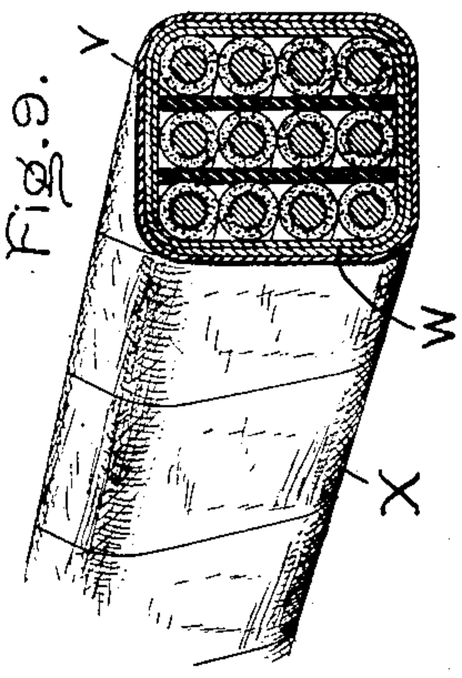


Fig. 8.

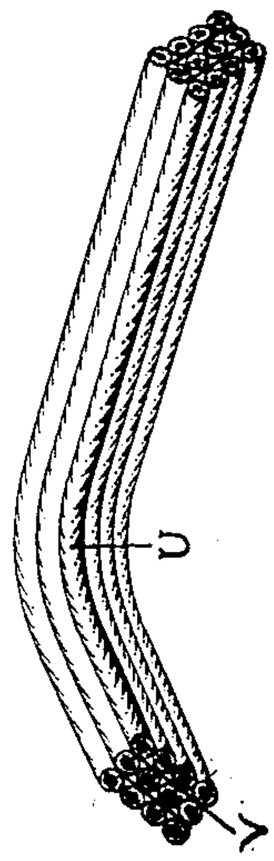
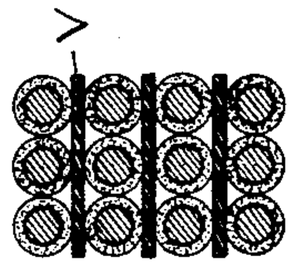


Fig. 10.



Witnesses.
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No. 733,232. Patented July 7, 1903.

UNITED STATES PATENT OFFICE.

JULIUS W. LUNDSKOG, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

WINDING-FORM.

SPECIFICATION forming part of Letters Patent No. 733,232, dated July 7, 1903.

Application filed June 21, 1901. Serial No. 65,428. (No model.)

To all whom it may concern:

Be it known that I, JULIUS W. LUNDSKOG, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Winding-Forms, of which the following is a specification.

Armature-coils of the well-known Eickemeyer type can be divided, when considered broadly, into two general classes—those consisting of a winding made of a single wire of as many convolutions as desired and those composed of two or more separately-wound coils which are afterward bound together to make a unitary structure.

My invention relates more particularly to forms for winding coils of the second class; but certain features of my invention are applicable to both classes, as will be more fully described hereinafter.

The object of my invention is to produce a simple form on which counterpart coils may be wound rapidly and in final shape without in any way causing abrasion of the insulation.

In the accompanying drawings, which illustrate an embodiment of my invention, Figure 1 is a plan view of a winding-form. Fig. 2 is a view in elevation of the right-hand end thereof. Fig. 3 is a left-hand end view in elevation. Fig. 4 is a rear elevation. Fig. 5 is a front elevation. Fig. 6 is a section taken on line 6 6 of Fig. 1 looking in the direction of the arrows. Fig. 7 is a plan view of a complete coil as wound on the form. Fig. 8 is a perspective view of a portion of three coils, showing a part of the means employed for uniting them. Fig. 9 is a perspective view of a portion of a coil, showing the complete means employed for uniting several similar coils into a unitary structure; and Fig. 10 is a cross-section of a modified form of coil.

Referring to the drawings by letter, A represents the base of the form on which the coil is wound. This base may be made out of wood or metal, as desired. It is provided with holes B, through which bolts or other securing means are intended to pass. In using the form it is intended to bolt it to the face-plate of a lathe or to some other rotating device, and the construction is such that it may be kept in practically continuous motion. The speed at which the form is rotated is only dependent on the ability of the winder to pass the wire around the offset-forming devices. Experienced winders are able to keep the form in almost continuous rotation from the time a coil is started until it is finished, the only interruption being when the wire is passed around the end hooks which form the offset, thus minimizing the amount of labor on each coil. In utilizing this form the wire is taken from a reel, a suitable tension device being provided between said reel and the form. If desired, the form may be held stationary and the wire cut to a definite length before being applied; but such an arrangement is usually objectionable because of the increased time required to make a coil.

The front face of the form is provided with a series of ledges or terraces C, Figs. 2 and 5, on which the wires of each successive layer rest, each ledge or terrace being arranged to support a single wire or convolution. The ledges are formed by fastening a number of flat plates D to the base. In Fig. 6 this feature is best shown, the ledges, however, being cut away on a slant to enable retaining-clips T to be slipped over the turns to hold them in place preparatory to removing the coil from the form. The object in making these ledges out of metal plates placed one over the other is to simplify the construction by using stock which is of the same thickness as the diameter of the wire, and it becomes a very simple matter to make these ledges by varying the width of the strips. For example, the plate next the base is one width, the next one slightly narrower, and so on, the thickness of the plates, however, being the same. It will thus be seen that between one plate and the next a shoulder or ledge is formed for each turn and that very little machine-work is required to make the form. It is necessary in making these forms that the distance between the center of the form and the various ledges shall vary slightly. This is due to the fact that the coils are placed on an armature in such a position that a plane passing through the center of the several turns is radial.

I have described one method of making the ledges when the base of the form is wood; but of course they can be cut from a single piece of stock, if desired. If the base is made of cast metal, the ledges may be made by cutting the stock forming the base or they may be made by cutting a removable piece which is attached to the base. In order to form the offsets in the ends of the coils, four hooks E F and E′ F′ or equivalent devices are provided. These hooks are arranged in pairs, one extending upward, while the other extends downward. The hooks E and E′ are carried by the base A, while the hooks F and F′ are carried by the removable piece or plate J, to be described later. The several ledges C on the front of the base have their corresponding ledges C′ on the ends of the form. At the start they are of the same width as those on the front, but gradually merge into one slot G as they approach the hook. This is best illustrated in the lower right-hand corner of Fig. 1. The object in having the several ledges merge into one as they approach the point of offset in the coil is to bring the wires into such position that they may be carried from the upper side of the form on one side of the center to the lower side of the form on the opposite side of the center in smooth and gradual curves, as is illustrated in the left-hand lower corner of Fig. 1, assuming that the center line passes through the space between the hooks.

The hooks E and E′ are curved outwardly at E^2 to enable the turns of the coil to change the plane which they occupied in passing along the ledges C and also to permit this change to be made in a smooth and gradual manner. This feature is clearly illustrated in the left-hand side of Fig. 1. In the present instance hooks are shown for forming the offsets; but pins may be substituted therefor under certain conditions. When pins are employed, they would of course coöperate in the same manner with the hooks F and F′ to form the offsets in the coils.

Referring now to the rear of the form, as viewed particularly in Figs. 1, 2, 3, 4, and 6, mounted on the back of the base or forming a part thereof is a flat metal plate H, which is beveled or inclined inwardly in order to bring the wires into the proper radial plane when mounted on the armature. A plane passing through the centers of the wires located on the ledges is radial with respect to a plane passing through the wires located on the inclined or beveled surface of piece H, and it is by reason of this arrangement that the sides of the coils occupy their proper positions on the armature without further bending. The plate H is not grooved except very slightly at the corners I, where it is done for the purpose of permitting the wires to lie more smoothly in place. Mounted on the top of the base and extending over the edge, at the rear thereof, is the detachable metal plate J, which is held in place by a bolt and wing-nut J′. The plate is secured at its inner edge by projecting under the longitudinal extending plate A′, Fig. 6, on the base and is partially retained in place thereby. In addition to this dowel-pins enter the openings J^2, Fig. 1. As shown in Fig. 6, the plate is made by uniting two pieces J^3 and J^4, and at opposite ends thereof are the hooks F and F′, which may be separate pieces retained in place by screws or may be formed integral therewith. The hooks are cut away in the same general manner as the hooks E and E′ are cut at E^2 and for the same purpose. The piece J^4 extends over the edge of the base and is directly engaged by the first wire applied to the form, each successive turn of wire resting on the previous turn. Near the ends I of the form the plate J^4 is provided with projections J^5, which are of service in preventing the wire from slipping out of place as the winding-form as a whole is rotated by the lathe or other source of power. In order that the first end of the coil be made the proper length and also retained in place during the winding, a gage K and clamp L are employed. These are both located on top of the movable plate J. The plate is arranged to form a part of the wire-clamping device. As shown, the hooks F F′ and E E′ are formed of separate pieces and afterward secured to the form, the hooks F and F′ being fastened to the plate J by screws, and are therefore movable with it, while the the hooks E and E′ are fastened by screws to the base A, and are therefore fixed. As viewed from the end, Fig. 2, it will be seen that the left-hand side of the form is somewhat higher than the right-hand side. This is done in order that the sides of the coil may assume the proper position after the coil is mounted on the armature. In placing the coils on the armature-core one side of each coil rests directly on the surface of the core or in the bottom of a slot, while the other side rests on top of the bottom side of another coil. The actual winding is all done on the base A, the plate J serving merely to hold the wires on the back side in place.

Mounted on the ends of the raised portion of the base near the offset-forming hooks are wear-plates M and N, and wherever there is an excessive amount of wear I prefer to mount detachable wear-plates, so as to protect the wood, it being necessary to keep the various dimensions of the coil as nearly uniform as possible.

In winding coils of this general class it is desirable, if not absolutely essential, to bring the leads which extend to the commutator out on corresponding portions of the coil, and preferably at the bottom of each side, in order to avoid crossing when the coils are connected to the commutator. This feature is attained in my improved form, as illustrated in Fig. 7. This arrangement serves to decrease the danger from short-circuiting, avoids projections

or bunches on the armature-periphery, and simplifies the connecting of the leads or ends to the commutator-bars.

Assume now that it is desired to wind a coil and that the form is mounted on a suitable power-driven support. The winder places an end of the wire O against the gage K and secures it under the clamp L. The wire is carried under the right-hand projection J^5 of the plate, thence along the inclined back plate II, and under the left-hand projection J^5 on the detachable plate, thence around the corner I and along the inclined end of the base A through the slot or opening formed in the hook F, where it crosses, and instead of being the upper wire it passes to the extreme bottom ledge C, as indicated in Fig. 2. As it passes along the front plate D the wire is unsupported except at the ends, Fig. 5. After reaching the right-hand end the wire turns and lies on the bottom ledge. It then passes over hook E′ and under hook F′ to the point of starting, thus making one complete turn. Further rotation of the form brings the wire forming the second convolution under the first, as indicated at 2, Fig. 3. The wire then passes along the back plate H underneath the first convolution until it passes under the left-hand hook F, when it again turns and becomes a top wire and rests on the ledge above the convolution 1. The wire is on top of the first convolution as it passes through the hook E′; but on passing through the hook F′ it changes again from an upper to an under layer and after passing the right-hand projection J^5 of the removable plate J becomes the beginning of the third turn or convolution. The wire continues until it passes the left-hand hook F, when it again appears on the upper side and passes along the ledge C, above the second turn, as indicated at Fig. 3. The wire remains on the upper side until passes from hook E to hook F′, when it again becomes an under wire. The fourth turn begins underneath the projection J^5 and continues as an under wire along the back of the frame, Fig. 4, until it passes through the hook F, when it again appears on top, as indicated in Figs. 1 and 3. The wire then passes along the upper ledge C on the front of the form and extends outward, as indicated by the dotted line, this portion indicated by the dotted line representing a commutator-lead. It will thus be seen that the two ends of the wire forming the coil are located on the same side thereof. This is clearly shown in the bottom plan view of the coil, Fig. 7, and the course of the various turns can readily be followed.

Referring to Fig. 7, at the start wire 1 forms the upper turn until it gets to the offset P, where it passes to the under side of the coil and remains an under wire until it gets to the offset Q. At this point it crosses from the under side and appears as 2 and is located directly underneath turn No. 1 until it gets to the offset P, where it again crosses to the upper side and remains until it gets to the offset Q, where it again passes under and forms turn No. 3 and remains under the other turns until it reaches the offset P, when it again passes to the top and remains so until it reaches the offset Q, where it again crosses and appears as the lower turn. The wire continues as the lower turn until it reaches the offset P, when it crosses and appears as the top wire. This being the last turn is extended straight out at the end, as is indicated, for the purpose of forming the commutator connection.

In the present instance I have shown the coil as being composed of four turns; but it may be composed of any number of turns desired, it being understood that the number of ledges and the other retaining parts would be correspondingly changed.

In order to temporarily retain the various wires in position after the coil is removed from the form, spring-clips T are employed, which are slipped into place after the coil is formed. These clips are arranged to enter a slot R, formed in the base A, which slot cuts the ledges C, as indicated in Figs. 5 and 6, and a slot S, which is formed in the detachable piece J. In order to remove the coil from the form, the clamp L is released and the end O of the wire bent out, as is indicated in dotted lines. The wing-nut J′ is then released, the plate tilted slightly to get the dowel-pins out of the holes J^2, when the entire plate is removed by pulling the inner edge thereof from under the strip A′ on the base. The coil can then be lifted from the form and is of the shape indicated in Fig. 7.

The form illustrated is arranged to wind coils having similar ends; but in certain instances the coils may be made with dissimilar ends, in which case the hooks would be correspondingly modified.

When desired to wind an armature with only a single coil per slot, the coil, as illustrated in Fig. 7, can be used after being suitably taped. It is customary, however, to use more than a single coil per slot, and in Figs. 8 and 9 I have illustrated a means for uniting two or more coils into a unitary structure. In making a coil which is composed of two or more single-turn coils which are afterward united it is necessary to use as many winding-forms as there are turns in the coil, and the only difference between one coil and the next or between one form and another is the slight change in the radii of the corners. These would have to be altered slightly for each coil. For example, the curve at U on the first coil is constructed with one radius, while the corresponding curve on the second coil is constructed with a different radius, and a third coil from a still different radius. This change has also to be made in those portions of the coils lying on the opposite side, only in an opposite sense. For example, if the radii of the first-mentioned curves are larger then

those of the second-mentioned sides will be made correspondingly smaller. This feature is indicated by the dotted lines Y in Fig. 7.

After the coils are properly formed they are slipped one into the other or "nested," and between the side portions and also between the ends, if desired, are inserted strips of paper or other insulating material V, covered with shellac or similar material. The coils are then put into a form subjected to heat, which melts the shellac or other material on the paper V and causes it to stick the several coils together. As soon as the shellac is melted the temperature of the coil is reduced, and when the shellac hardens the coil is removed. When a coil is thus united, the several parts are firmly united, and it may be freely handled, or even put on an armature; but for various reasons it is deemed best to add extra insulation. To provide for this, a wrapping of insulating fabric W is placed over the side of the coil, and over this is wound tape X in a spiral manner. This spiral wrapping of tape extends over the ends as well as the sides. The coil when completed has all of the ends brought out from the bottom of the coil. The coils described are known as "three-turn coils" and are so united that the strips of insulation V, which are covered with shellac, extend radially; but where "four-turn coils" are united in this manner the strips V are placed at right angles to those of the three-turn coil, as indicated in Fig. 10. With the four-turn coil three wires per coil are shown, as against four wires per coil in the three-turn coil. In making up a compound coil the amount of shellac or other material on the strips V is usually made sufficient to saturate the insulation on the wire; but if additional insulation is required more may be used. It is evident from the above that the means for uniting the coils may be applied to coils having varying numbers of turns and layers and, furthermore, that the invention is applicable to coils other than those intended for armatures.

I have described a method of uniting the several coils when it is desired to form a compound coil; but the method is not claimed herein, as it forms the subject-matter of a separate application, bearing Serial No. 65,430, filed June 21, 1901.

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

1. In a wire-bending device, the combination of a base having a wire-supporting surface on one side and a second wire-supporting surface on the other, a plate which extends beyond the edge of one of the sides for holding the wire in place, and means for directing and guiding the end portions of the wires from one side to the other so that the wires on one side will occupy one of the surfaces while those on the other side will be situated below the edge of the plate.

2. In a wire-bending device, the combination of a base having wire-supporting surfaces on both sides thereof, a plate which is detachably secured to the base and extends beyond one of the sides for assisting to hold the wire in place, and means carried by the plate which guide and direct the wire in its passage from one side of the base to the other.

3. In a winding-form for coils, the combination of a base having wire-receiving surfaces on opposite sides thereof, an offset-forming means secured to one end thereof, a plate detachably secured to the base for holding certain wires in place, and a hook carried by the detachable plate which coöperates with said means on the base to form an offset in the coil.

4. In a coil-winding form, the combination of a base having wire-receiving surfaces, a single detachable plate which holds all of the wire on one of the surfaces in place and is taken off in removing the coil, and a gage which is carried by the plate.

5. In a coil-winding form, the combination of a base having a series of ledges on one side arranged like steps, a smooth inclined surface on the opposite side, the ledges and surface being so disposed as to hold the wires in radial planes, and a detachable means which rests on the base and extends over the edge thereof for retaining the wires on the inclined surface in place.

6. A winding-form composed of a base having a series of ledges or terraces, each of which is composed of a single piece of stock that is substantially equal in thickness to the diameter of the wire used in forming the coil.

7. In a coil-winding form, the combination of a base having wire-receiving surfaces on the sides which incline toward each other, hooks for holding the wires against one of the surfaces, and a single detachable plate which projects from the base over the other surface to hold the wires in place during the process of winding, and which is detached to permit the removal of the coil.

8. In a coil-winding form, the combination of a base around which the wire is wound, a plate detachably secured to the base which extends outward beyond an edge thereof and retains certain of the wires in place, a means for holding the inner edge of the plate, and other means for holding the outer edge of the plate.

9. In a coil-winding form, the combination of a base having fixed wire-receiving surfaces which are arranged to form the coil, with a plate detachably secured to the base which extends outward beyond an edge thereof and retains certain of the wires in place, and a wire-clamping device which is formed in part by the plate.

10. In a coil-winding form, the combination of a base on which the wire is wound, offset-forming means secured to opposite ends thereof, a plate for holding certain of the wires in place, which must be detached be-

fore the coil can be removed, end hooks mounted on the plate, the hooks coöperating with said means to form offsets in the ends of the coil, and means for uniting the base and plate.

11. In a coil-winding form, the combination of a base having fixed wire-receiving surfaces, a detachable plate which assists to hold the wires in place, a wire-retaining clamp carried by the plate, and a means for holding them in place.

In witness whereof I have hereunto set my hand this 18th day of June, 1901.

JULIUS W. LUNDSKOG.

Witnesses:
DUGALD MCK. MCKILLOP,
JOHN J. WALKER.