PATENTED NOV. 14, 1905.

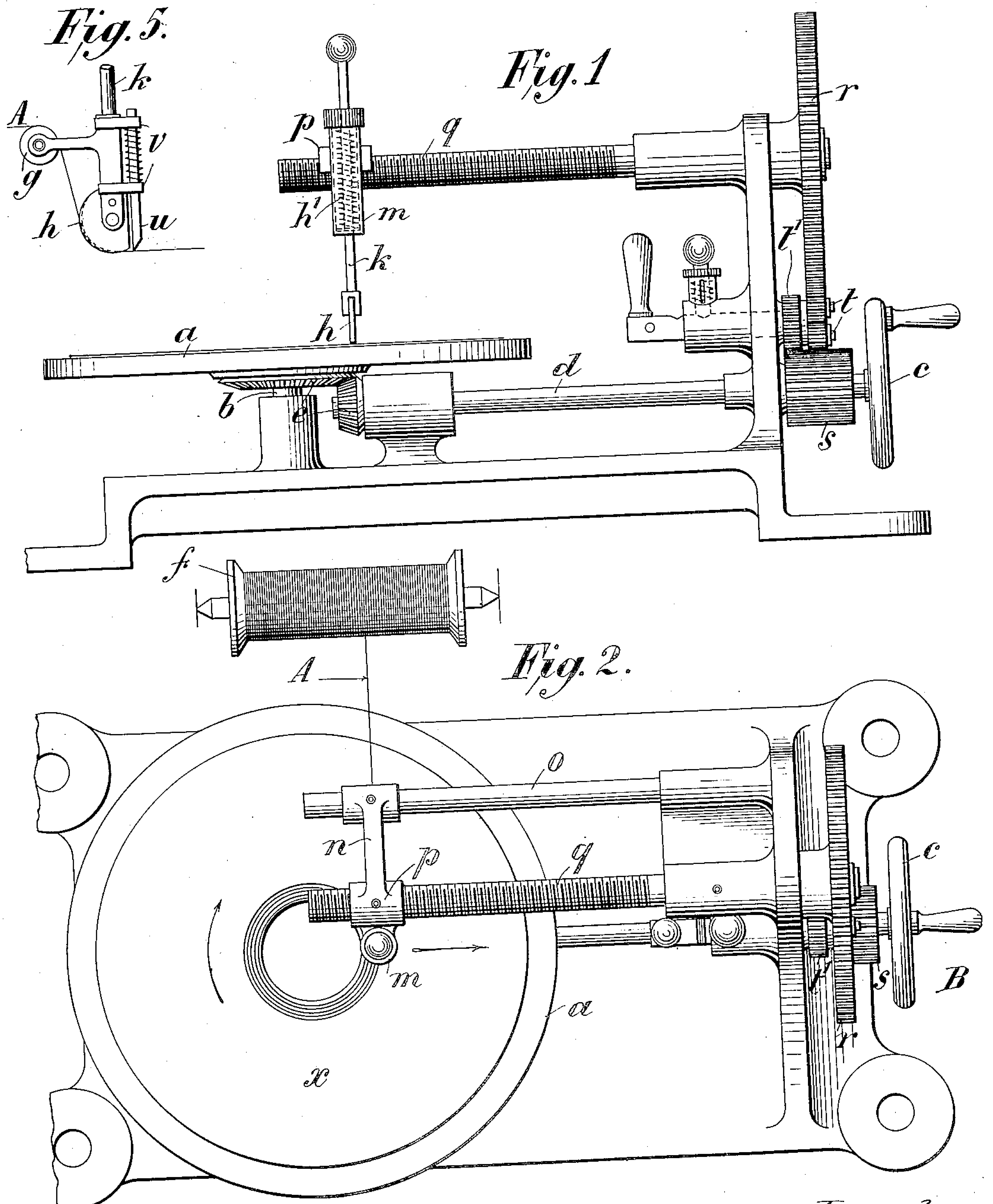
No. 804,250.

L. B. MILLER.

APPARATUS FOR THE MANUFACTURE OF INDUCTION COILS.

APPLICATION FILED MAR. 9, 1904.

4 SHEETS—SHEET 1.



Witnesses.
F. J. Brongham
Geo. B. Price

Inventor.
Leslie B. Miller
by his Attorney
W. Lloyd Wise

No. 804,250.

PATENTED NOV. 14, 1905.

L. B. MILLER.

APPARATUS FOR THE MANUFACTURE OF INDUCTION COILS.

APPLICATION FILED MAR. 9, 1904.

4 SHEETS—SHEET 2.

Fig. 3.

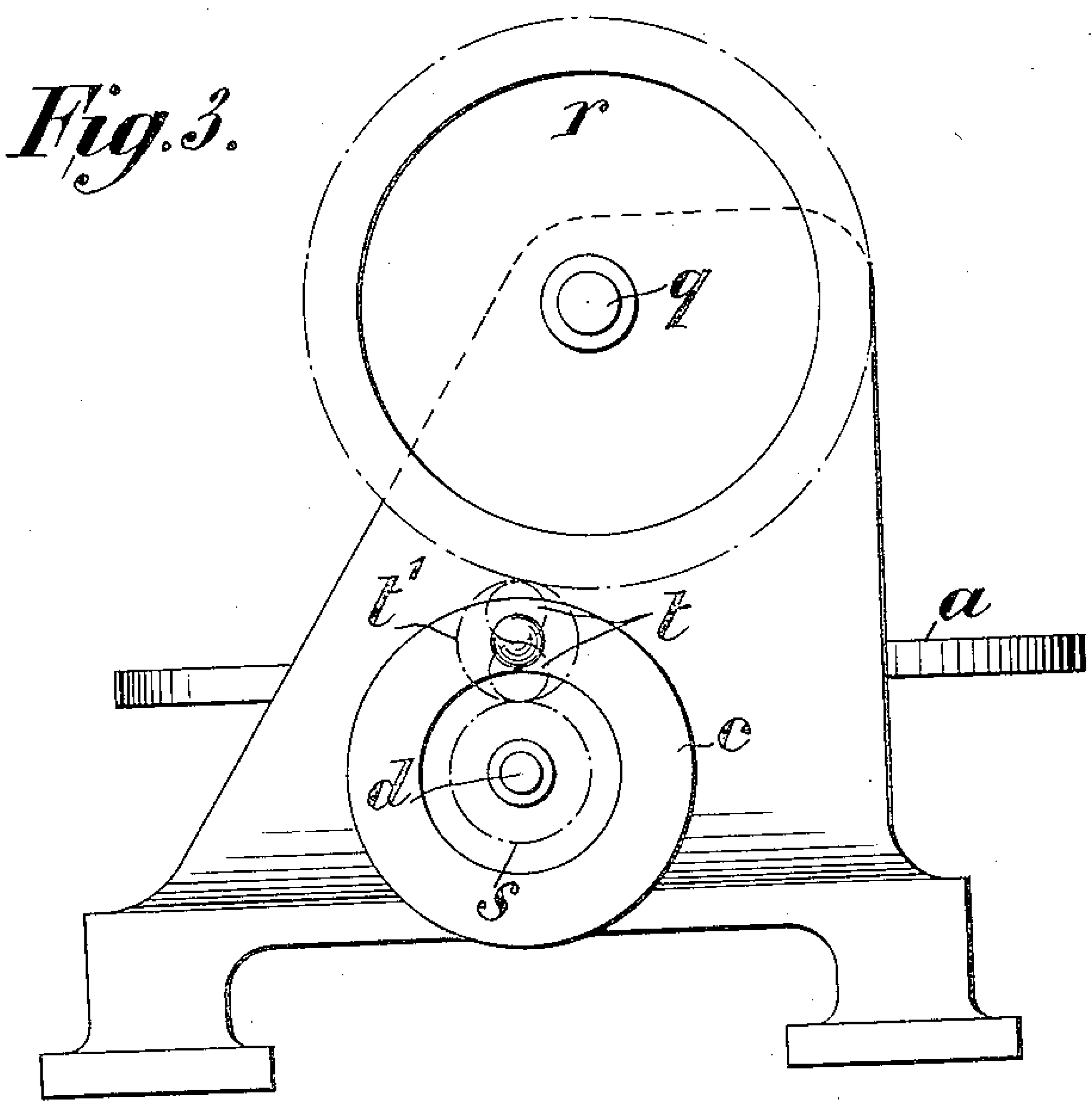


Fig. 4.

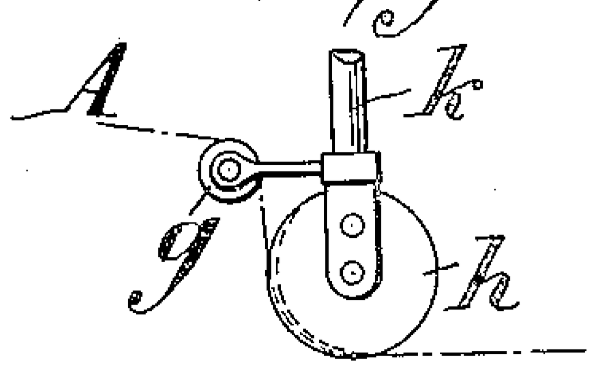


Fig. 9.

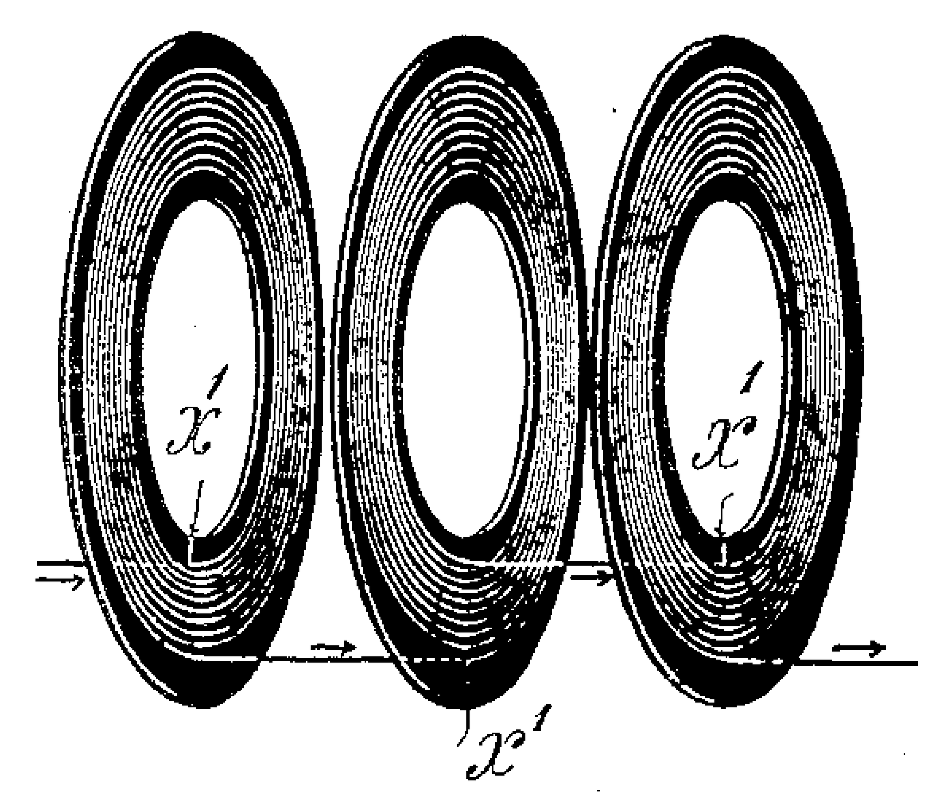
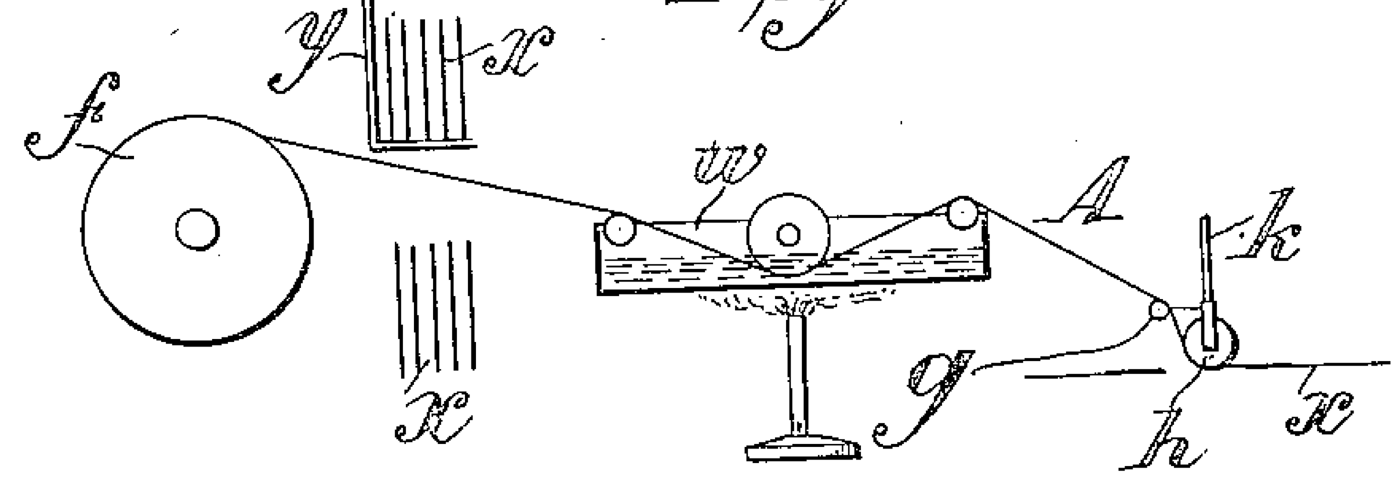


Fig. 6.



Witnesses.
F. J. Brougham
Geo. R. Brice

Inventor:
Leslie B. Miller
by his Attorney
W. Lloyd Wise

No. 804,250.

PATENTED NOV. 14, 1905.

L. B. MILLER.

APPARATUS FOR THE MANUFACTURE OF INDUCTION COILS.

APPLICATION FILED MAR. 9, 1904.

4 SHEETS—SHEET 3.

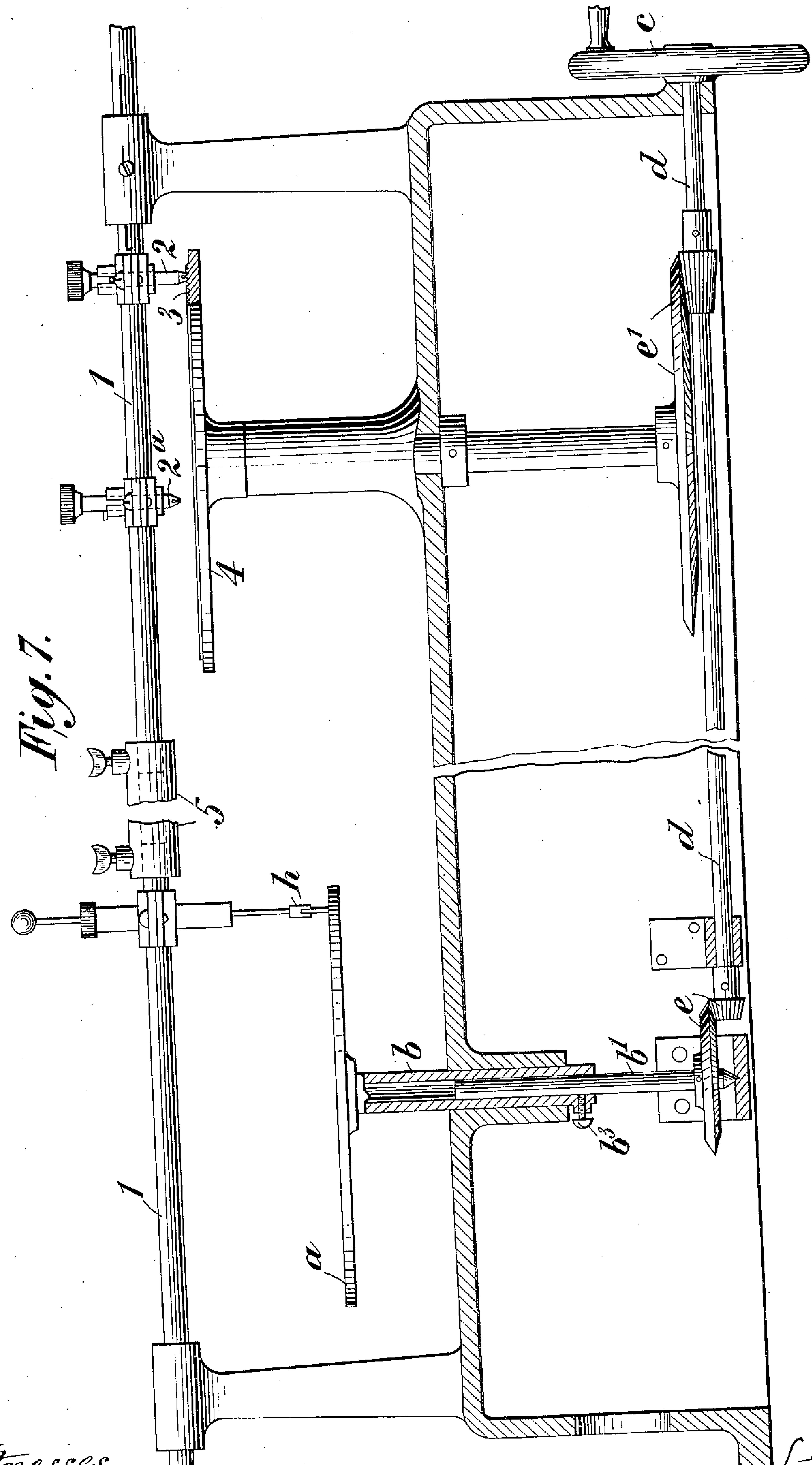


Fig. 7.

Witnesses.
F J Brougham
Geo B Price

Inventor.
Leslie B. Miller
by his Attorney
Waldo D Wise

No. 804,250.

PATENTED NOV. 14, 1905.

L. B. MILLER.

APPARATUS FOR THE MANUFACTURE OF INDUCTION COILS.

APPLICATION FILED MAR. 9, 1904.

4 SHEETS—SHEET 4.

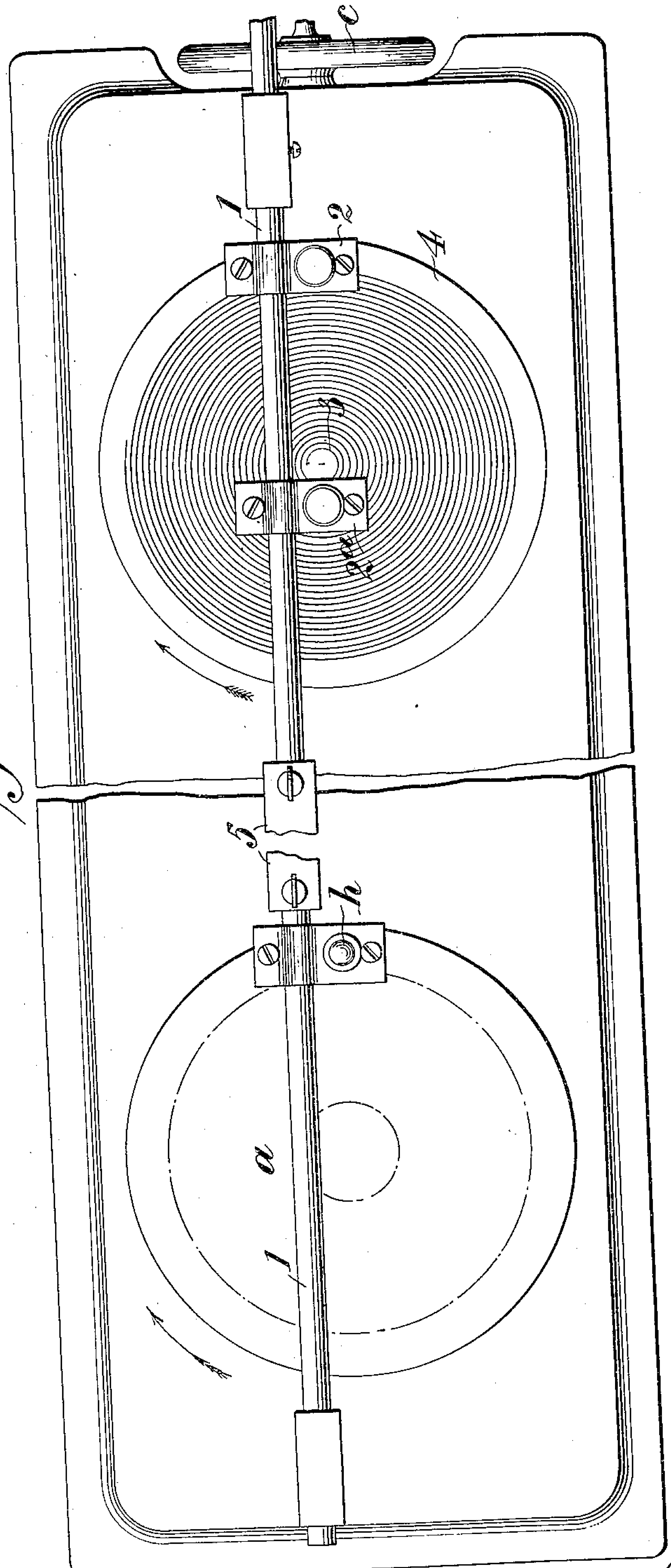


Fig. 8.

Witnesses:
F. J. Bingham
Geo B. Price

Inventor
Leslie B. Miller
by his Attorney
W. Lloyd Wise

UNITED STATES PATENT OFFICE

LESLIE BRADLEY MILLER, OF LONDON, ENGLAND.

APPARATUS FOR THE MANUFACTURE OF INDUCTION-COILS.

No. 804,250. Specification of Letters Patent. Patented Nov. 14, 1905.

Application filed March 9, 1904. Serial No. 197,380.

To all whom it may concern:

Be it known that I, LESLIE BRADLEY MILLER, a subject of the King of Great Britain and Ireland, residing in London, England, have invented Improvements in and Apparatus for the Manufacture of Induction-Coils, of which the following is a specification.

This invention relates to the construction of high-tension coils for induction-coils or other electric apparatus. In theory each section of the high-tension portion of such a coil should consist of one wire wound on itself in such a way that each convolution lies on the top of the one wound immediately before it, like a clock-spring. In practice the sections of large induction-coils, such as are used for wireless telegraphy and X-rays apparatus, are usually each about two millimeters thick, the wire being wound between two disks placed this distance apart, with the result that owing to irregular winding it often happens that convolutions of wire between which a considerable difference of potential obtains come close together and sooner or later cause short-circuiting of a small portion of the winding. This seriously interferes with the efficiency of the coil and generally leads to a complete breakdown of the coil.

Now the present invention has reference to the manufacture of the high-tension portions of induction-coils of fine wire—for example, No. 36 standard wire-gage—that is to say, wire having a diameter of about .2 millimeter—the wire being wound in flat spirals like a clock-spring of any required diameter, one wire thick, and with any predetermined distance between the adjacent convolutions of wire, the winding of the wire being effected from the inner to the outer circumference of one spiral and back again from the outer to the inner circumference of the next spiral, and so on without any break in the continuity of the wire until the end of the wire is reached. A section of an induction-coil, comprising, for example, a hundred or more flat helices of the kind described, each one wire thick and totaling up to about one and a half to two inches in axial thickness, is then for convenience taken off the winding-machine and subjected to considerable pressure while warm, so as to convert it into a solid or compact block. The outer end of the wire is then joined to another section of flat helices made in a similar way and the other end of which is connected to a third section, and so on to form a secondary winding of the desired length to form, in conjunction with a primary winding, an induction-coil of the required power. By the construction described there are very few joints in the whole of the secondary winding of the induction-coil, and even these are wholly on the outside of the coil.

The invention consists in the novel form of induction-coil hereinafter more particularly specified in the claims.

In the accompanying illustrative drawings, Figures 1, 2, and 3 show, respectively, in side elevation, plan, and end elevation apparatus suitable for winding flat helices of fine wire according to this invention. Fig. 4 shows, to a larger scale, a device hereinafter called a "guide," which both guides the wire into its desired position on the surface to which it is to be attached and presses it upon such surface so that it will then remain in place, at the same time allowing the following portion of wire to slide continuously under it. Fig. 5 shows the guide combined with a heating and cutting device. Fig. 6 is a diagrammatic view. Figs. 7 and 8 show, respectively, in sectional side elevation and plan a modified construction of winding apparatus. Fig. 9 shows diagrammatically three flat insulated helices of fine wire wound on three insulating-disks according to this invention.

Referring to Figs. 1 to 6, inclusive, *a* is a circular metal plate mounted on a spindle *b* so as to revolve, preferably horizontally. It is driven from a hand-wheel *c* through a shaft *d* and bevel-gearing *e*. On the face of the plate a ring *x*, of paper, is stuck, having its surface coated with paraffin-wax. Onto this coated ring fine insulated wire A is drawn from a revolving drum *f*, Figs. 2 and 6, over a suitably-grooved roller *g*, Figs. 4, 5, and 6, so arranged that the wire emerges at an angle to the plate *a* from under a guide *h* close to the paraffined paper, the drum *f* being mounted to turn quite freely. The guide has a grooved rear side and a flat lower side and is pressed down by a spiral spring *h'*, Fig. 1, and is geared so as to travel outward and inward along a radius of the disk at a suitable rate and causes the wire A to be laid on and also pressed into the surface of the ring *x* in a clock-spring helix. For this purpose, in the example now being described, the guide *h* is carried by a rod *k*, that extends through a cylindrical holder *m*, carried by a lever *n*, that is mounted to turn and slide endwise upon a horizontal rod o and is provided with a half-nut p, that engages a screw q. This screw is rotated by a toothed wheel r, driven from a pinion s on the shaft d through reversing interchangeable wheels t t and t'. Just in front of the guide h there may be provided a metal blade u, Fig. 5, adapted to act as a plow and cut a fine groove in the surface of the paraffin-wax, into which the wire falls. The cutter may be heated by a spiral of resistance-wire v wound round it and heated electrically, or it may be warmed by a gas-flame, so as to melt the wax slightly. It works well if placed just where the wire ceases to hold on the surface of the ring of paper, in which case it should follow the guide. The wax cools and sets round the wire as the disk recedes, thus keeping the winding firmly in the desired position on the surface.

The wire may be pressed in by a roller following the cutter or guide, and an independent motion can be given to the roller, so as to cause the disk to revolve under it. I find, however, in practice that the heated cutter or plow may be dispensed with if the wire be coated with a hot liquid insulating material—as, for example, by drawing it through melted paraffin-wax in a vessel w, Fig. 6. This warms the wire, and if it be then pressed by the guide h upon a layer of slightly warm paraffin-wax made by brushing over the surface of the paper ring x with a brush dipped in hot wax it will readily adhere and remain in the position in which it is wound, no matter whether the convolutions of wire are so close as to touch one another or whether there is a small space between each in order to obtain the highest insulation between the convolutions. When one helix wound from center to circumference is finished, a paper ring is placed over it, and the next may be wound from circumference to center after changing the direction of motion of the guide h, as by moving the wheels t t t' endwise, without any break being made in the continuity of the wire.

To avoid making a joint or cutting the paper ring right across one side for the third layer, the wire should be threaded through the ring. In practice a considerable number of these rings are threaded over the wire before the winding is commenced, as shown at x in Fig. 6, and, being held in a suitable clip y, are taken one by one as required. Each ring is slit for a part of its width to allow of the wire passing through it at the inner or outer periphery of the helix, as shown at x' in Fig. 9.

By proceeding in the manner described fine-wire coils of any size can be made with jointless sections, Fig. 9, without any jointed ends from which wasteful brush discharges can take place and secure from possibility of breakdown. In a coil so constructed the sections thereof can be safely forced together with considerable pressure without danger of short-circuiting any of the convolutions, thereby enabling greater efficiency to be attained by diminishing brush discharge. The insulation between the convolutions of each helix is also improved, as the convolutions are not wound in contact with one another, but are each fixed independently upon an insulating-surface, with a space of any determined width between the successive convolutions, such space being variable at will by altering the velocity ratio between the revolving bed and radial guide.

If the electric tension between two helices is only to be moderately high, no paper disk need be used, and one helix can be wound directly on the other or for convenience on a thin metal disk that is slit on one side and which can then be afterward freed from the wire by a thin-bladed knife and withdrawn, or the direction of winding may be reversed, so that when the metal disk is turned over and the wire separated from it by the application of heat current will flow in the same direction through both helices.

Instead of using insulated wire bare wire may be employed, each turn being separated from the next by a narrow space, which may or may not be filled with insulating material. The wire may be heated by passing a current through an inch or more of it between the guide h and the roller g, which is then insulated.

It is the possibility of winding with bare wire that constitutes a marked distinction between coils constructed according to this invention and all other coils wound in vertical sections of whatever width in which successive convolutions are wound more or less on the top of one another in the manner already described and in which the coil could not work at all if bare wire were used, as the whole length of wire would be short-circuited upon itself and act like a metal disk.

Instead of passing the wire through hot paraffin, Fig. 6, other insulating materials can be used, such as a mixture of several parts of resin to one of boiled linseed-oil. A surface of paper or other insulator coated with these will remain sufficiently adhesive for some days to hold the wire in position without the use of heat, and there is then no necessity to pass the wire through a bath of liquid insulating material, or the guide h may, as shown, respectively, in Figs. 7 and 8, be moved radially by connecting it to a horizontal slide-rod 1, to which is also connected a pin 2, (hereinafter called a "feeler,") the lower end of which is notched to engage a scroll-thread 3 of Λ section cut in the surface of a horizontal plate 4, suitably geared to the horizontal table a. The plate and table may, as shown, be rotated continuously in the same direction from the shaft d through bevel-gearing e and e'. In this case the radial inward movement of the guide h can be effected by engaging the feeler 2 with the outer right-hand portion of the thread 3 and rotating the plate 4 in the direction of the arrow. The radial outward movement of the guide h is effected by disengaging the feeler 2 from the inner end portion of the thread 3 at one side of the center of motion and engaging it with the outer left-hand portion of the thread at the diametrically opposite side of the center of motion. To enable this to be done, the feeler 2 may be arranged to be lifted out of engagement with the thread 3 and the portion of the slide-rod 1 carrying it be moved endwise to the necessary extent into a holder 5, fixed to the portion of the slide-rod carrying the guide h. This arrangement also admits of the making of coils of different diameters, or the slide-rod may, as shown, be provided with two vertically-movable feelers 2 and 2^a, adapted to be engaged alternately with diametrically opposite portions of the thread 3 and to be held in a raised inoperative position, or instead of shifting the single feeler from one side of the center of motion to the other or using two feelers a single feeler may be used and the radial inward and outward motion of the guide h be produced by reversing the direction of motion of the scroll-plate 4, the table a being continuously rotated in the same direction.

The scroll-plate 4 may, as shown, be rotated at a slower rate than table a, so as to admit of the use of a coarse thread 3 thereon. Also the table a may be made vertically adjustable, so that it can be lowered from time to time to prevent undue compression of the spring h', and therefore undue pressure between the guide h and the insulating material on which it bears, caused by accumulation of superimposed helices of wire on the table. For this purpose the shaft carrying the table may be made in two parts b b', arranged telescopically one within the other and detachably connected together by a screw b^3.

By suitably altering the gearing between the rotary table and radially-movable wire-guiding device any desired distance can be produced between the successive convolutions of wire in the helices of wire produced by the machine.

As it is impracticable to wind thick wire by the method described, in order to increase the cross-section several fine wires may be wound side by side or several helices may be connected in parallel.

What I claim is—

1. As a new article of manufacture, a section of high-tension winding for an induction-coil, comprising a number of flat connected helices of fine wire, each helix being composed of a single wire wound in a single plane, and insulating material that is normally solid but is capable of being softened and which is arranged to separate and hold the helices from each other and by which each convolution of wire is separately held in place.

2. As a new article of manufacture, a section of high-tension winding for an induction-coil, comprising a number of flat connected helices of fine wire each formed of a single wire wound in a single plane, sheet insulating material separating the successive helices from each other and insulating material that is normally solid but is capable of being softened applied to the sheet insulating material and by which each convolution of wire is held separately in place.

3. As a new article of manufacture, a section of high-tension winding for an induction-coil, comprising a number of flat helices of fine wire connected together alternately at their inner and outer peripheries and formed of a continuous length of wire, each helix being composed of wire wound in a single plane, and insulating material that is normally solid but is capable of being softened separating the helices from each other and by which each convolution of wire is held separately in place.

4. As a new article of manufacture, a high-tension section for an induction-coil, comprising a number of flat helices of fine wire connected together alternately at their inner and outer peripheries and formed from a continuous length of wire each helix being composed of wire wound in a single plane, and sheet insulating material separating the successive helices from each other, and insulating material that is normally solid but is capable of being softened applied to the sheet insulating material and by which each convolution of wire is separately held in place.

Signed at London, England, this 18th day of January, 1904.

LESLIE BRADLEY MILLER.

Witnesses:
H. D. JAMESON,
A. NUTTING.