C. H. THORDARSON.

MACHINE FOR MAKING INSULATING ELEMENTS.

APPLICATION FILED APR. 20, 1914.

1,220,377.

Patented Mar. 27, 1917.

3 SHEETS—SHEET 1.

Fig. 1.

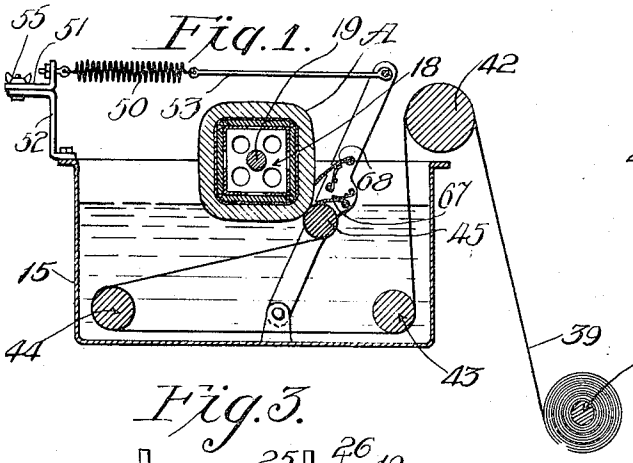


Fig. 2.

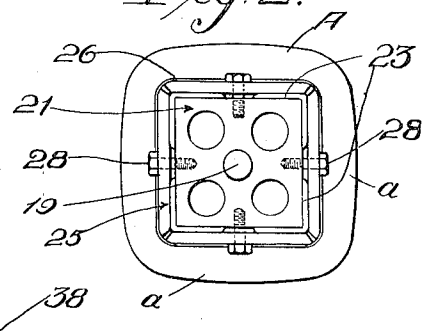


Fig. 3.

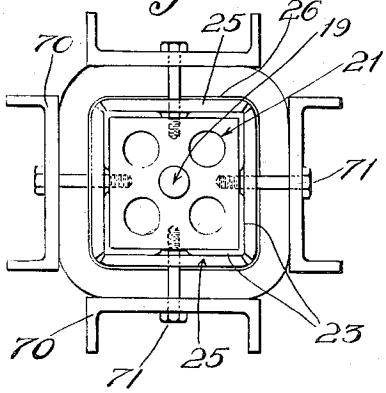


Fig. 4.

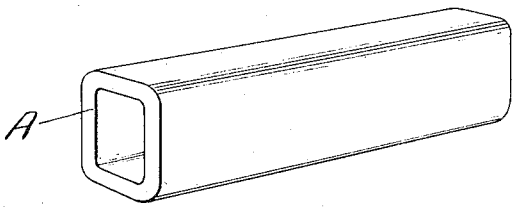


Fig. 5.

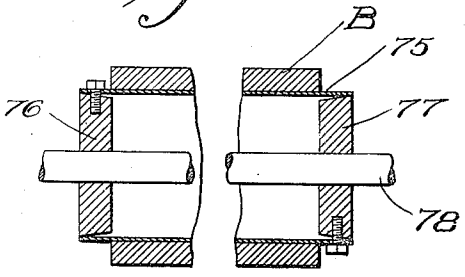


Fig. 6.

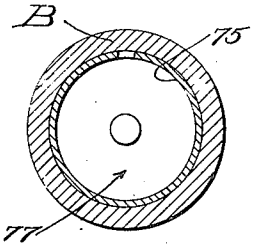


Fig. 7.

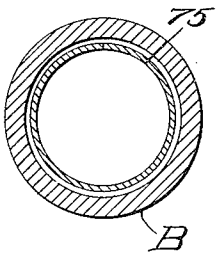
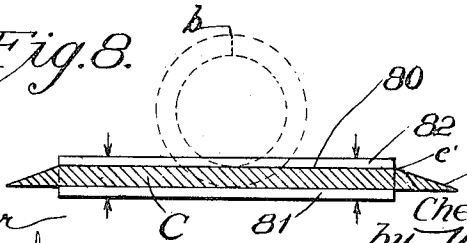


Fig. 8.



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3 SHEETS—SHEET 2.

Fig. 9.

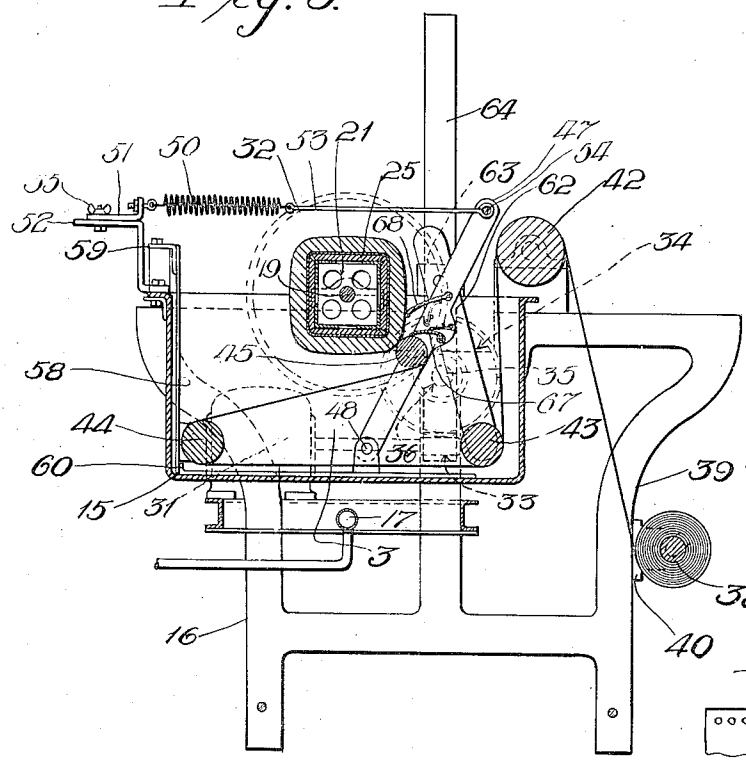


Fig. 13.

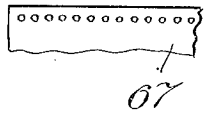
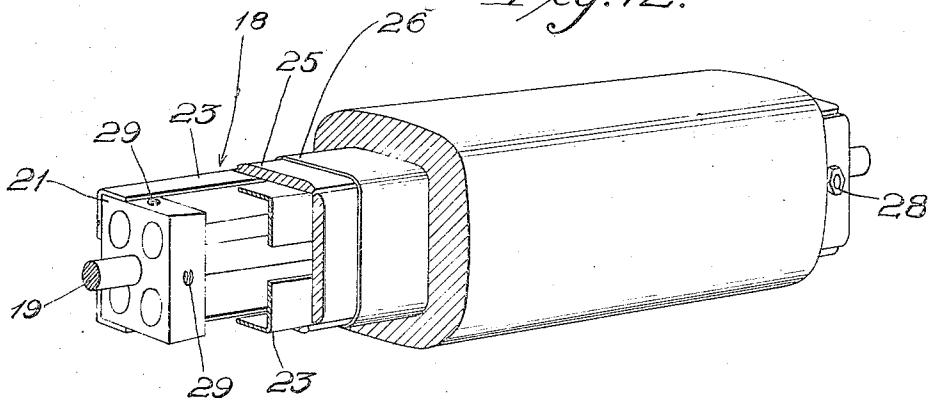


Fig. 12.



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1,220,377.

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3 SHEETS—SHEET 3.

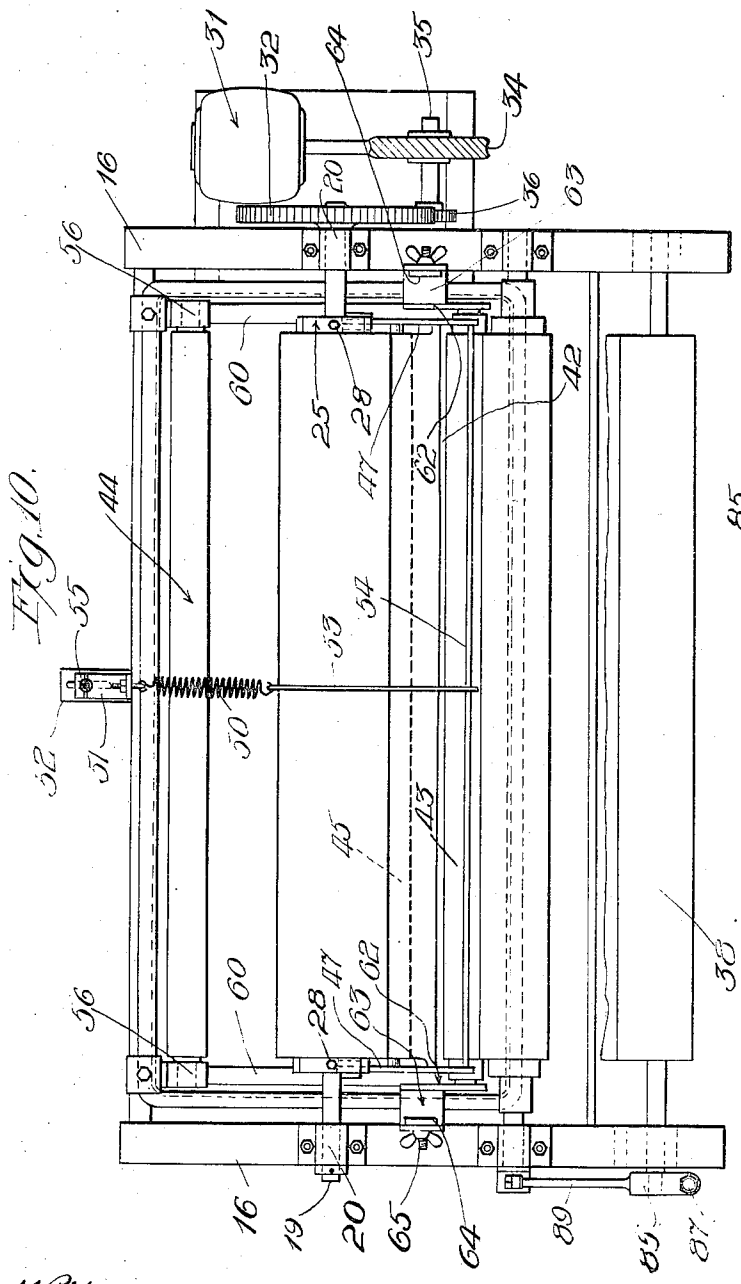

Fig. 10.

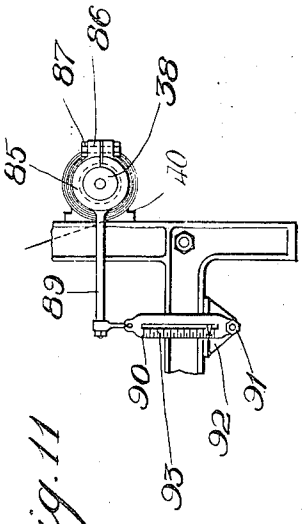

Fig. 11

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UNITED STATES PATENT OFFICE.

CHESTER H. THORDARSON, OF CHICAGO, ILLINOIS.

MACHINE FOR MAKING INSULATING ELEMENTS.

1,220,377. Specification of Letters Patent. Patented Mar. 27, 1917.

Application filed April 20, 1914. Serial No. 833,182.

To all whom it may concern:

Be it known that I, CHESTER H. THORDARSON, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Machines for Making Insulating Elements; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the characters of reference marked thereon, which form a part of this specification.

This invention relates to a novel machine for making insulating elements, either of flat or tubular form, for use in insulating conducting elements of electrical and electro-magnetic devices, and the invention consists in the combination and arrangement of elements shown in the drawings and described in the specification and is pointed out in the appended claims.

An insulating element embodying my invention (and which may be made in the form of a sheet, or a tube of various cross sections) consists of a hard, rigid body portion that comprises a plurality of layers or sheets laid one upon the other and highly compressed, with an insulating compound spread between and impregnating said sheets or layers uniformly throughout the mass. Such insulating compound is applied while hot and hardens upon cooling so as to constitute, in addition to its insulating properties, a factor in imparting rigidity to the body.

The method for making said insulating elements consists essentially in winding a sheet of suitable fibrous, somewhat porous, insulating material about a rotating form, to thereby produce a tube and applying to the said sheet at the time of forming the same into the tube a heated insulating compound in the form of a liquid which impregnates the sheet throughout its area, and whereby also a film of such insulating compound is applied between the successive layers of the resultant roll or tube, and expelling air and water from between the layers as they are wound upon the roll, the compound subsequently hardening so as to produce an exceedingly hard and rigid structure which possesses an enormous insulating capacity as compared to its thickness.

When the insulating element assumes the form of a flat sheet it may be made by longitudinally slitting or dividing the tube after it has been formed and before the insulating compound hardens, and thereafter flattening said tube or shell and applying pressure to press the layers together while the insulating compound between and impregnating the layers hardens.

When the insulating element has the form of a tube of generally rectangular cross section, such as are used in many transformers embodying a core of rectangular cross section, pressure may be applied exteriorly to the wall of the tube before the same has hardened to compress the layers of the tube between the corner angles thereof to give flattened form to the sides thereof.

In practice, the sheet of insulating material from which the body of the insulating tube or other element is produced may be reeled upon a rotating mandrel or form of collapsible structure so that it may be collapsed after the formation of the tube and removed therefrom. The said form or mandrel may be mounted in a suitable tank or receptacle which is adapted to contain a bath of heated liquid insulating compound so that the sheet is passed through the melted compound on its way to the form and becomes thereby impregnated with the said compound. Preferably also the collapsible form is rotated in such adjacency to the melted or liquid compound that the forming tube is partially submerged in said compound to thereby more efficiently impregnate the layers which make up the tube. When employing apparatus, such as suggested, the form may be of generally rectangular cross section, and while the newly formed tube remains on the form pressure is applied to the longitudinal sides of the tube to compress the layers between the corner angles thereof, which layers have a tendency to bulge outwardly during the forming operation, by reason of the non-circular cross section of the tube. Such pressure may be applied by means of suitable longitudinal presser plates through the medium of screw threaded or other convenient available power. When the insulating element is to assume a flat form, the tube or shell produced on the collapsible form is removed from the form while hot and is thereafter

flattened and compressed while the insulating compound is cooling, between upper and lower presser plates of suitable dimensions to exert uniform pressure throughout the area of the flattened sheet.

In the drawings:—

Figure 1 is a diagrammatic transverse section of the essential elements of a machine for practising my improved method.

Fig. 2 is an end view of the form with a newly formed tube thereon.

Fig. 3 is a like view showing a method of compressing the sides of a rectangular tube to flatten the same.

Fig. 4 is a transverse view of one form of insulating tube embodying my invention.

Fig. 5 is a longitudinal sectional view, broken away, of another construction of form with the tube thereon.

Fig. 6 is a transverse view of the construction shown in Fig. 5.

Fig. 7 is view similar to Fig. 6, showing the form collapsed.

Fig. 8 is a diagrammatic view showing the manner of producing a flattened form of insulating element.

Fig. 9 is a transverse view of the machine for carrying the process into effect.

Fig. 10 is a plan view of the machine.

Fig. 11 is a detail illustrating a tension device applied to the roll from which the sheet is unwound onto the forming member.

Fig. 12 is a perspective view broken illustrating the construction of the form or mandrel with the tube formed thereon and before the said form has been collapsed to remove it from the tube.

Fig. 13 is a fragmentary detail of a scraper bar for removing globules of air and water from the sheet just as it is being wound upon the form.

In Figs. 1 to 8, inclusive, of the drawings, are illustrated the several steps or stages of producing both the tubular and the flat form of insulating element, and in Figs. 9 to 12, inclusive, is illustrated a mechanism which may be employed to carry the process into effect, and which will be readily understood when compared to the steps of the process shown in Figs. 1 to 8, inclusive.

First referring to the general elements of the machine, 15 designates an open-topped receptacle, made preferably of sheet metal, which is adapted to contain the bath of insulating compound. Said receptacle is supported on end frames, designated as a whole by 16, 16, made of any suitable or preferred configuration and suitably connected together. The contents of the receptacle or tank 15 may be heated either by electricity, a steam coil or a burner pipe, which latter is herein shown and designated by 17.

One type of form or mandrel 18 on which the sheet material to produce the tubular insulating element is wound is illustrated most clearly in Figs. 2, 3 and 12 and is made as follows:

19 designates a shaft which extends longitudinally across the open-topped receptacle 15 and is mounted in suitable bearings 20, 20 supported on the end frame 16. The said bearings may be made of any suitable or preferred construction to permit removal of the form. The said shaft 19 carries at its ends blocks 21 provided with central openings or apertures adapted to snugly fit the shaft. Extending between said blocks 21 are a series of parallel bars 23, 23 herein shown as having the form of angle bars, and each adapted to fit at its ends upon the corners of the blocks 21, with the members of the bars overlapping the adjacent edge faces of the blocks. The said edge faces of the blocks are tapered inwardly, as indicated in Fig. 12, so that the blocks may be moved endwise away from the bars to collapse the form. The body of the form comprises further elongated members 25 which fit over and laterally bridge between the bars 23 and extend from end to end of the form. Said members 25 are exteriorly shaped to give the desired interior cross section to the tube formed thereon. Surrounding the members 25 is a sheet metal casing 26 which is made sufficiently thin to conform to the members 25 and constitutes the surface on which the layers of the insulating material are immediately wound; said casing being provided to afford a smooth and continuous non-stitching surface on which the layers are wound. The said members 25 may be held in the form by means of screw-bolts 28 which extend through openings in the members 25 and into screw-threaded openings 29 in the edge faces of the blocks 21.

The form may be slowly rotated from a suitable motor 31 supported at one end of the frame and geared to a spur wheel 32 that is non-rotatively fixed, in any convenient manner, to one end of the shaft 19. If the bearings 20, 20 be divided bearings, the spur wheel 32 may be fixedly attached to the shaft and removed from the machine with the form. As herein shown, the driving gearing between the motor and the shaft comprises a worm 33 on the motor shaft which meshes with a worm wheel 34 on an intermediate shaft 35 that carries a pinion 36 to mesh with the spur wheel 32.

38 designates a reel on which the roll of insulating sheet 39 is carried and from which the sheet is directed to the rotating form. The shaft of said reel is mounted in suitable bearing brackets 40 attached to the end frames of the machine. The sheet 39 is carried to the form over a guide roll 42 mounted between the end members of the machine frame above the open-topped receptacle; below two guide rolls 43, 44

mounted in suitable bearings at the bottom of the receptacle, and one at each lateral side thereof, and beneath a pressing or ironing roll 45 arranged closely adjacent to and parallel with the form at the line where the sheet is laid upon said form. The said roll 45 is placed under the influence of suitable spring or gravity pressure whereby the roll is yieldingly held pressed toward the form.

As shown herein the ironing roll is carried by and movable with arms 47, 47 arranged one at each end of the machine, and pivoted at their lewer ends at the ends of the casing bottom by means of pivot pins 48. The tension means by which the roll 45 is variably pressed toward the form or mandrel 18 consists, as herein shown, of a spring 50 which is connected at one end by an adjustable connection 51, to an arm 52 which extends upwardly from the casing 15, and is connected at its other end, through the medium of a link 53, to a cross rod or bail 54 that extends between and is attached at its upper ends to the ironing roll carrying arms 47. The adjustment of said ironing roll spring is shown as effected by slotting the arm 52 to receive a locking bolt 55 by which to lock the plate 51 to said arm.

The guide roll 44 is herein shown as mounted in bearings 56 carried by the lower ends of brackets 58 that are detachably fixed at 59 in any suitable manner to the upper rear edges of the receptacle 15, whereby the roll may be removed for the purpose of cleaning same. In order to prevent the roll from being pulled away from the rear wall of the tank 15 by the tension stress of the insulating sheet 39, the brackets 58 extend behind the upturned ends of brace bars 60 arranged transversely across the bottom of the receptacle.

The roll 43 is also removably mounted on the receptacle. As herein shown, the shaft of said roll 43 is carried by arms 62 which are carried at their upper ends by slotted blocks 63 that are suitably mounted on vertically arranged bars 64 which extend upwardly from the end frames of the machine. The said blocks are adapted to be locked to the said bars 64 in vertically adjusted positions by means of clamping bolts 65 or other suitable clamping devices. Thereby the roll 43 may be adjusted vertically in the receptacle 15 to facilitate threading the insulating sheet beneath the roll and may be raised out of the receptacle for the purpose of cleaning the roll.

In order to remove water and bubbles of air from the insulating sheet as the sheet rises from the liquid or melted insulating compound in the receptacle around the ironing roll 45, I may provide a scraper 67 that extends between and is carried by the ironing roll supporting arms 47 and is spring pressed toward the winding sheet on a line immediately adjacent to the application of the sheet of paper to the winding form. Preferably the ironing roll is partially submerged in the melted insulating compound and the scraper bar engages the sheet on said roll just above the level of the liquid. The said scraper is preferably perforated near its scraping edge, as shown in Fig. 13, so as to permit air which may rise between the ironing roll and scraper to escape. Any air which may rise from the liquid against the forming tube may be scraped off by a second scraper bar 68 that is carried by the ironing roll arms and is spring pressed toward said tube.

In the operation of the machine, a roll of insulating sheet supported on the reel 38 is threaded over and under the various guide rolls before referred to, and is attached at its leading edge in any suitable manner to the form 18. Thereafter the form is rotated slowly to wind the insulating material upon the same. The sheet, in its passage through the melted insulating compound, which latter is heated to a temperature to maintain the same in a liquid state, becomes impregnated by said compound. Not only does the sheet become so impregnated, but a film of the compound adheres to the sheet so that between each layer of the tube thereby formed there remains a film which adds to the insulating properties of the compound impregnated body. When the form is of general rectangular cross section, as indicated by A in Figs. 1, 2, 3, 9 and 12, there is a tendency for the layers between the corner angles of the resultant tube to be wound somewhat more loosely than at the corners and to thereby bulge outwardly, as indicated at *a* in Fig. 2. In order to flatten the outer sides of the tube or shell I may apply presser plates 70, such as are shown in Fig. 3, which extend longitudinally of the form and are adapted to be clamped to the end blocks of the form, in any suitable manner, by means of screw-threaded bolts 71 which extend through openings in the presser plates and into the same holes 29 which receive the fastening bolts 28. After the pressure has been thus applied to the soft, impregnated tube it is allowed to cool, whereby the walls of the tube harden or set to produce the resultant or finally rigid tube of the desired cross section. Thereafter the form is collapsed by pulling the blocks 21 outwardly away from the bars 23, after the screws 71 have been removed, whereby the said bars 23 and the members 25 collapse or fall inwardly and may be readily removed from the finished tube A.

In Figs. 5, 6 and 7, I have shown a form adapted to produce a cylindric tube B. In

this construction the form consists of a longitudinally slit mandrel 75, end pieces or plugs 76, 77 and an axial shaft 78 on which the plugs snugly fit. The peripheries of the plugs are tapered inwardly so that when forced into the hollow mandrel they serve to open or spread the same, as shown in Fig. 6. The mandrel is made of sufficient thickness to make it stiff enough to resist the tension imposed thereon during the rolling of the tube on the form. The end pieces or plugs 76, 77 are removed when the mandrel is to be collapsed, whereupon the resiliency of the mandrel causes it to close, as indicated in Fig. 7, so that it may be withdrawn from the tube B. When the insulating tube is to be used in its cylindric form as an insulating element it is allowed to cool upon the form.

When it is desired to produce a flat sheet, the tube produced by either of the forms, and preferably by the cylindric form, is slitted longitudinally, as indicated at *b*, in Fig. 8, and is spread flat to produce the sheet C. The sheet is compressed during the time the insulating compound is cooling between upper and lower clamping members 80, 81 by any suitable pressing devices, indicated by the arrows in Fig. 8. The pressure applied to the insulating element during the hardening or setting operation may be otherwise effected, as for instance, by air pressure, as where the element is fabricated in a vacuum and allowed to harden under atmospheric pressure. Such an arrangement is shown in my co-pending application for Letters Patent, Serial No. 15,930, filed on the 20th day of March, 1915. The tapered edges of the sheet produced by flattening the slitted cylinder may be thereafter sheared off on the dotted lines indicated at *c'* to produce squared edges.

A tension is applied to the sheet between the roll on the reel 38 and the form so that the sheet may be tightly wound upon the form so as to lay the layers closely and compactly upon each other. As herein shown, the tension means consist of a brake that is applied to the reel 38. The said brake may comprise a divided collar 85, the ends 86 of which are apertured to receive a clamping bolt 87 by which the collar may be clamped upon the reel, or a part which rotates therewith, with varying pressures, depending upon the tension suitable to be applied to the sheet. The said collar and reel are provided with suitable friction surfaces as are common in such brake devices. The said brake collar is anchored to a fixed part of the machine to maintain a suitable tension on the sheet. As herein shown, an arm 89, fixed to or integral with the collar, is connected to one end of a link 90, the other end of which is connected, as by means of a pin 91 to a bracket 92 fixed to the frame. The said link 90 preferably has the form of a spring scale, embracing a spring element which constitutes a yielding anchor for the brake collar, and an indicator point which is movable over a graduated dial 93 to indicate the tension applied to the sheet.

An important feature of the method of making insulating elements, as described, is embraced in the steps or stages whereby the sheet is wound upon the form or mandrel at a high tension so that the successive layers are laid closely and tightly upon each other during the formation of the insulating tube or element, combined with the step of impregnating the sheet with the insulating compound as the tube is formed, and maintaining the compactness of the resultant body (or increasing it in certain parts thereof) during the time the compound sets or hardens. Thereby is produced an exceedingly hard, rigid and compact body which has an enormous resistance to the passage of an electric current. Moreover, thereby air and water entrained in the melted insulating compound is expelled from between the turns of the resultant laminated structure, so that the structure of the wall has practically the same resistance qualities as a solid shell. The expulsion of the air and water from the laminated tube is greatly facilitated by the application of the scraper devices immediately at the line of laying the sheet on the form. The presence of air or water in the body of the tube is highly objectionable and the means whereby these elements may be excluded constitute a very important step in the manufacture of the tube or shell.

A further advantage derived from the invention is the low cost at which the insulating element may be produced. The material which enters into its composition is comparatively inexpensive and the power required to operate the machine, when a machine is employed to practise the method, is very small. The product described is not herein made the subject of the claims, but the same is claimed in a divisional application hereof, Serial No. 28,553 filed on 17th day of May, 1915.

I claim as my invention:—

1. A machine for the purpose set forth comprising a receptacle to contain a liquid insulating compound, a winding form mounted in the receptacle and adapted to be partly submerged in the liquid, during the winding, with means to rotate it and to feed a sheet of insulating material through the liquid and reel it on said form.

2. A machine for the purpose set forth comprising a receptacle to contain a liquid insulating compound, a winding form mounted in the receptacle in position to be partly submerged in the liquid during the winding, with means to rotate it and to feed

a sheet of insulating material through the liquid and reel it on said form, and a smoothing element for pressing the sheet on said form at the line of laying the sheet thereon.

3. A machine for the purpose set forth comprising a receptacle to contain a liquid insulating compound, a form mounted in the receptacle in position to be partly submerged in the receptacle during the winding, with means to rotate it and to feed a sheet of insulating material through the liquid and reel it on said form, and a smoothing roller held against the sheet at the line of laying the sheet thereon.

4. A machine for the purpose set forth comprising a receptacle to contain a liquid insulating compound, a winding form mounted in the receptacle in position to be partly submerged in the receptacle during the winding, with means to rotate it and to feed a sheet of insulating material through the liquid and reel it on said form, a smoothing roller spring pressed against the sheet at the line of laying the sheet thereon and means to vary the pressure of said roller against said form.

5. A machine for the purpose set forth comprising a receptacle to contain a liquid insulating compound, a winding form mounted in the receptacle and adapted to be partly submerged in the receptacle during the winding, with means to rotate it and to feed a sheet of insulating material through the liquid and reel it on said form, a smoothing element for pressing the sheet on said form at the line of laying the sheet thereon, swinging arms in which said smoothing element is rotatively mounted, adjusting means, with spring connections between the same and said arms, and means to lock the adjusting means in different positions of adjustments.

6. A machine for the purpose set forth comprising a receptacle to contain a liquid insulating compound, a winding form mounted in the receptacle and adapted to be partly submerged in the liquid during the winding, with means to rotate it and to feed a sheet of insulating material through the liquid and reel it on said form, a smoothing element for pressing the sheet on said form at the line of laying the sheet thereon, and a wiping member in contact with said sheet just in rear of the smoothing element.

7. In a machine for the purpose set forth, a collapsible form comprising a collapsible body, a shaft arranged axially therein and blocks fitted to the shaft and having relatively movable, inwardly tapered portions to engage in the ends of the collapsible body and movable relatively thereto in the axis of said shaft.

8. In a machine for the purpose set forth, a collapsible form comprising a collapsible body, a shaft arranged axially therein, blocks fitted to the shaft and having relatively movable, inwardly and oppositely tapered portions, to engage in the ends of the collapsible body and movable relatively thereto, in the axis of said shaft, and means to attach the form body to said blocks.

9. In a machine for the purpose set forth, a collapsible form comprising a shaft, blocks thereon movable toward and from each other and having inwardly tapered peripheries and members extending between said blocks and directly and non-yieldingly supported at their ends on said peripheries, whereby the blocks may be removed endwise from said members to permit the form to collapse.

10. In a machine for the purpose set forth, a collapsible form comprising a shaft, blocks thereon having inwardly tapered peripheries and members extending between said blocks and supported at their ends on said peripheries, whereby the blocks may be removed endwise from said members to permit the form to collapse and pressure bars to engage the exterior sides of a tube reeled on said form, with means to press them inwardly against said tube.

11. In a machine for the purpose set forth, a collapsible form comprising a shaft, blocks thereon having inwardly tapered peripheries and members extending between said blocks and supported at their ends on said peripheries, whereby the blocks may be removed endwise from said members to permit the form to collapse, bars applied to the exterior faces of a tube reeled on said form, and screws passing through said bars and engaging screw-threaded holes in said blocks to press the bars on said tube.

12. In a machine for the purpose set forth, a collapsible form comprising a shaft, apertured rectangular blocks fitted thereto and having inwardly tapered edges, angle bars fitted to the corners of and extending between said blocks, and members laterally bridging said angle bars from end to end thereof and removably attached to said blocks.

13. A machine for the purpose set forth comprising a receptacle to contain a liquid insulating compound, a form mounted in said receptacle to rotate partially submerged in the liquid, means to feed an insulating sheet through the liquid and reel it on said form, a laying-on roller to press the sheet against said form as it is wound thereon, and means for freeing the sheet of air and water as it is wound on said form.

14. A machine for the purpose set forth comprising a receptacle to contain a liquid insulating compound, a form mounted in said receptacle to rotate partially submerged in the liquid, means to feed an insulating sheet through the liquid and reel it on said form, a laying-on roller to press the sheet against said form as it is wound there-

on, and scraper means acting on said sheet to scrape water and air globules therefrom before it is reeled on the form.

15. A machine for the purpose set forth comprising means for fabricating an insulating element of laminated structure, comprising assembling means with means to support it partially submerged in a body of insulating material and means to feed the sheet laminæ to said assembling means and to operate the assembling means.

16. A machine for the purpose set forth comprising a receptacle to contain a liquid insulating compound, a form mounted in said receptacle to rotate partially submerged in the liquid, means to feed an insulating sheet through the liquid and reel it on said form, and means located immediately adjacent to the line of laying on of the sheet on the form to free the sheet of air, gases and water.

17. A machine for the purpose set forth comprising a receptacle to contain a liquid insulating compound, a form mounted in said receptacle to rotate partially submerged in the liquid, means to feed an insulating sheet through the liquid and reel it on said form, a laying-on roller to press the sheet against said form as it is wound thereon, means to produce a substantial tension on the sheet to wind it closely on the form and means closely adjacent to the line of laying on of the sheet on the form to free the sheet of air, gases and water.

18. A machine for the purpose set forth, comprising a receptacle to contain a bath of liquid insulating compound, a rotative winding form, with means to rotate it, means to feed a sheet of saturatable insulating material through the liquid and reel it on said form, said form being located in such immediate adjacency to the said bath that the saturated sheet is laid tightly thereon immediately adjacent to its line of emergence from the bath and means between the bath and form to free the surface of the sheet of free fluid.

19. A machine for the purpose set forth comprising a receptacle to contain an insulating compound, a rotatable form within the receptacle, means to feed an insulating sheet through the liquid and feed it on said form, and means separate from the form to free the sheet of air, gas or water.

In testimony, that I claim the foregoing as my invention I affix my signature in the presence of two witnesses, this 17th day of April A. D. 1914.

CHESTER H. THORDARSON.

Witnesses:

G. E. DOWLE,

W. L. HALL.