

Jan. 11, 1944.

C. J. BEAVER ET AL

2,339,045

MEANS FOR IMPREGNATING AND COATING SHEET MATERIAL

Filed Feb. 20, 1942

4 Sheets-Sheet 1

FIG. 3.

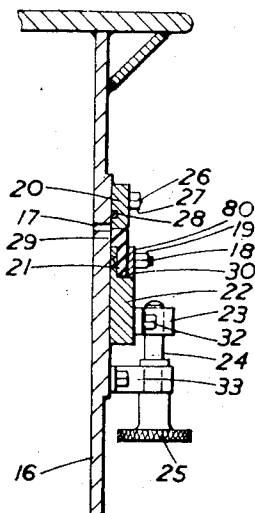
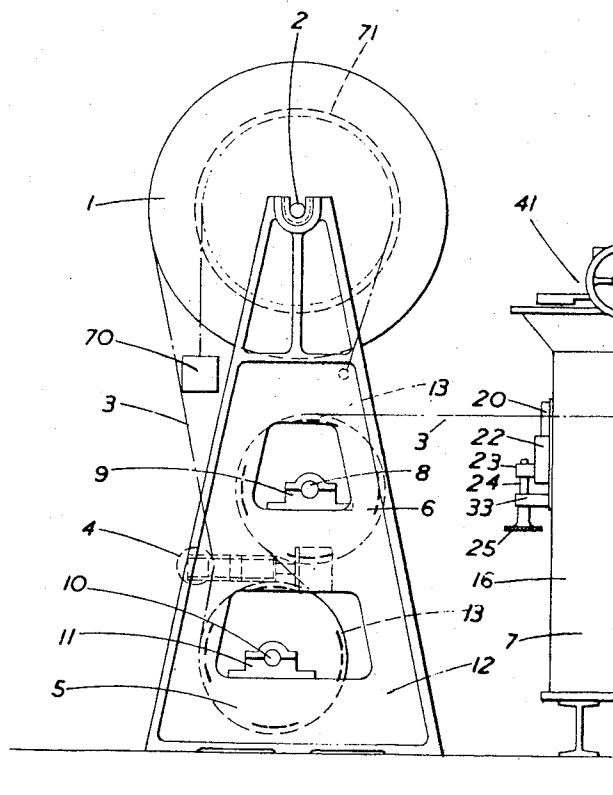


FIG. 1.



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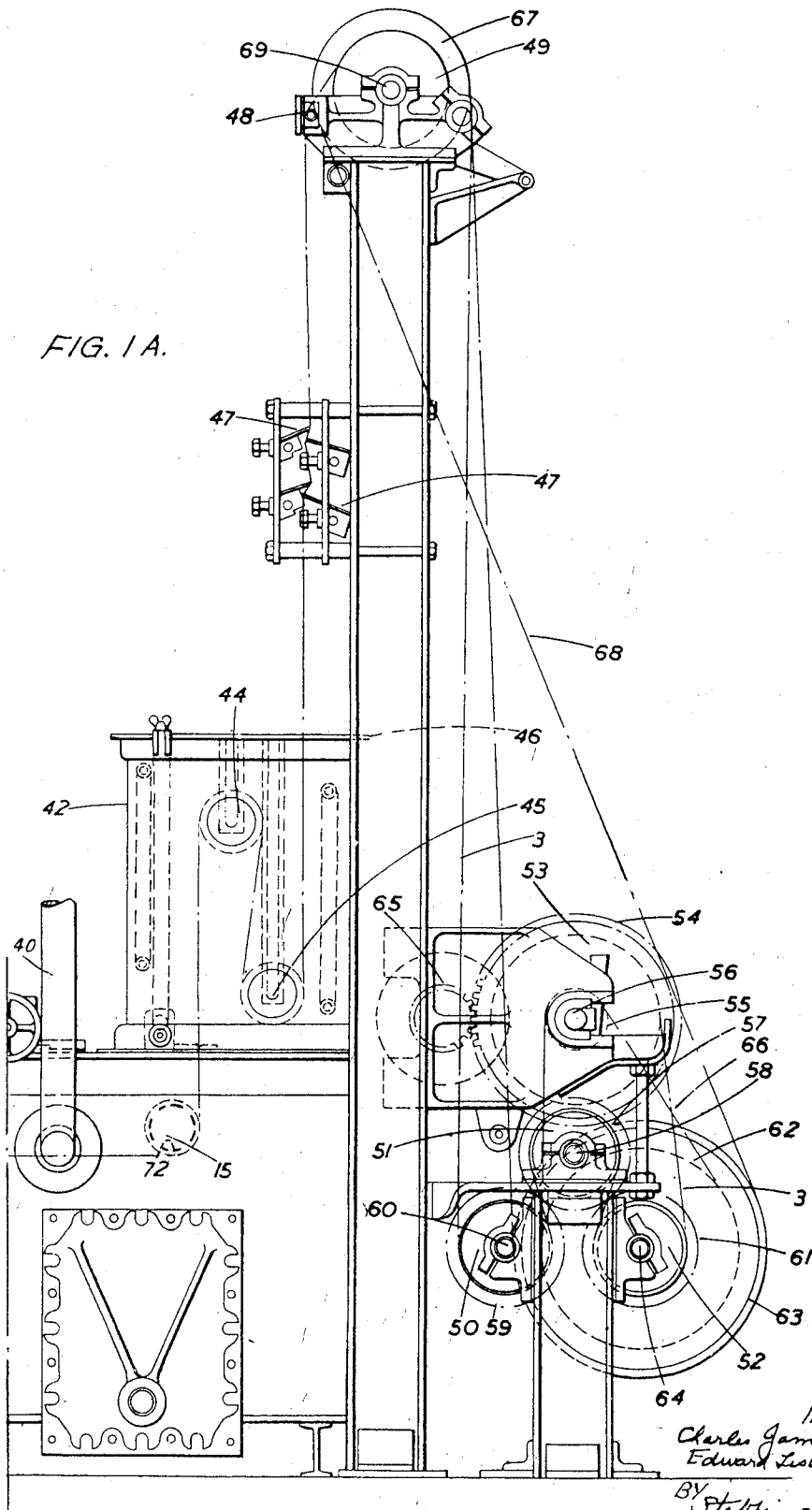
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4 Sheets-Sheet 2

FIG. 1 A.



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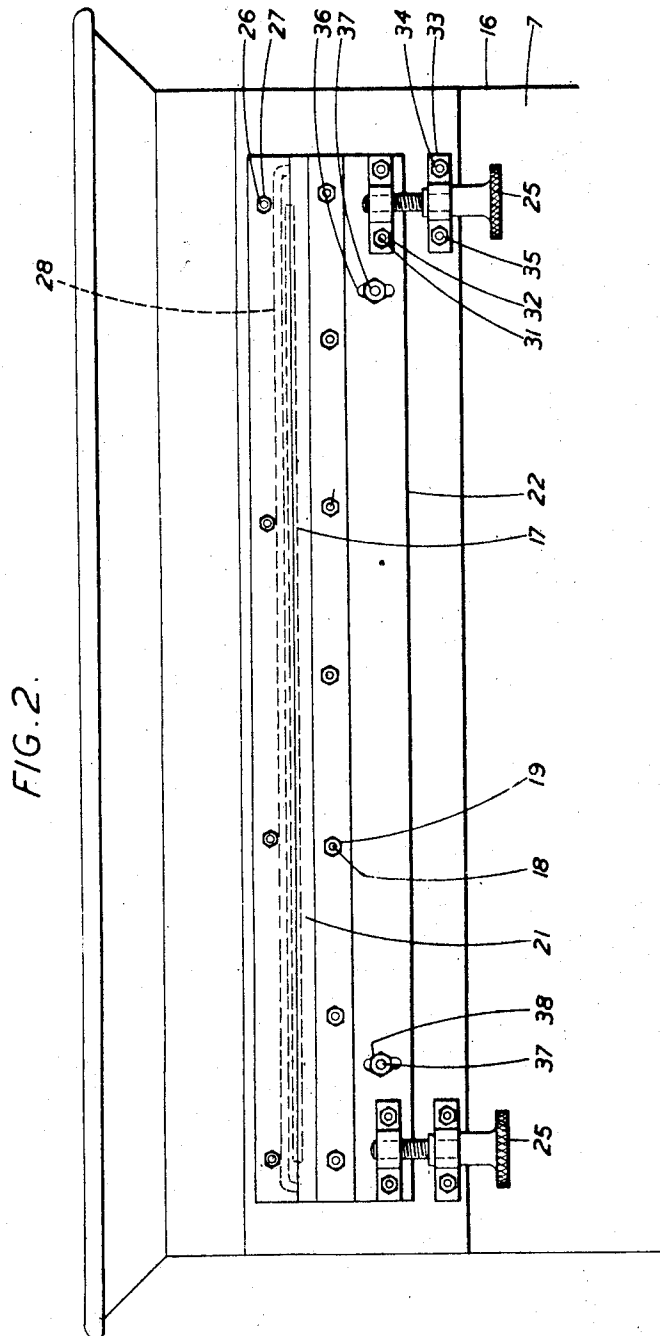
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MEANS FOR IMPREGNATING AND COATING SHEET MATERIAL

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4 Sheets-Sheet 3



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4 Sheets-Sheet 4

FIG. 4.

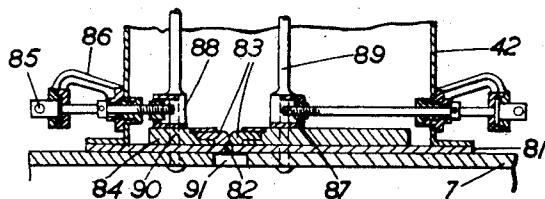


FIG. 5.

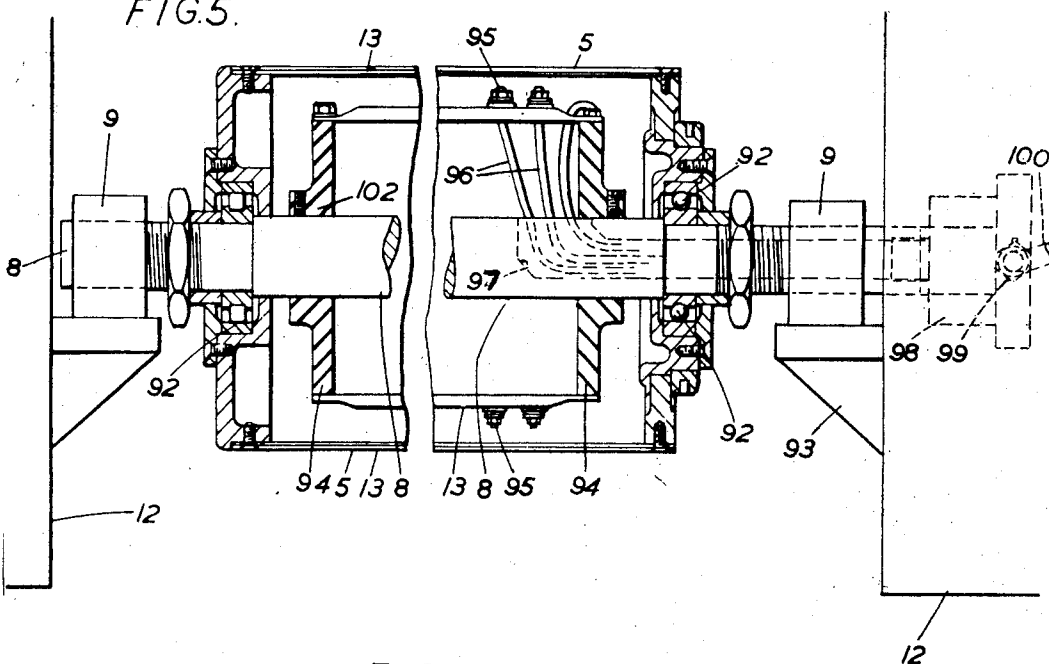
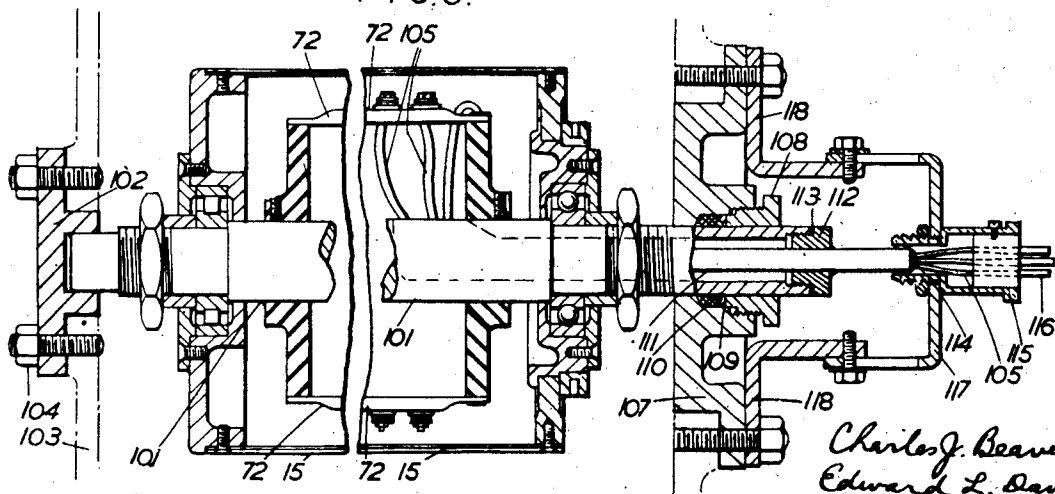


FIG. 6.



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UNITED STATES PATENT OFFICE

2,339,045

MEANS FOR IMPREGNATING AND COATING
SHEET MATERIAL

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Application February 20, 1942, Serial No. 431,644
In Great Britain May 26, 1941

3 Claims. (Cl. 91—32)

Beaver Patent 1,958,984 discloses apparatus for impregnating and/or coating sheet material (which is understood to include material in the form of narrow strips) in a continuous operation. Examples of the materials treated are paper and textile fabrics. Examples of the impregnating and/or coating materials are oil, insulating compounds, varnish and rubber solution. This material may be in a liquid or semi-liquid state. In the apparatus there described the sheet material, in the form of a roll, is placed on a support in a vacuum drying chamber, and is passed from the roll over hot rollers, for the purpose of heating it for drying, and then through an aperture, of small width, with an appropriate packing arrangement, in the separating wall between the drying chamber and the impregnating tank. At this point the sheet material passes directly into the body of impregnating material in the tank. This material is under a pressure superior to the pressure in the drying chamber—usually it is at atmospheric pressure—and impregnation takes place mainly at the entry into the tank, where an abrupt change of conditions takes place. The sheet material then travels on through the tank and then upward from the tank to a drying or setting arrangement.

The present invention provides an improved form of such apparatus. In this improved form the whole or greater part of the drying operation is performed outside the vacuum chamber and the sheet material passes into that chamber for a short final treatment to prepare it for impregnation (as before) by the impulsive action which takes place at the abrupt change of pressure. The improved apparatus comprises a small vacuum chamber which (as before) is arranged directly adjacent to the impregnating tank so that the sheet material can pass through a slot in the separating wall. This vacuum chamber preferably has a hot roller round which the sheet material passes, or other heating means. Outside this vacuum chamber are a support for the roll of untreated sheet material and hot rollers so arranged that the material passes round them as it comes from the roll on the way to the vacuum chamber, which it enters through a slot provided with a packing device. It then travels onwards through the vacuum chamber and from it into the impregnating tank and then to the final drying or setting arrangement. This final operation may involve the use of heat, but frequently will consist simply in the cooling of the sheet material by passing it through the atmosphere whereupon the impregnating material sets or becomes vis-

cous to a sufficient extent to be retained by the material.

The invention will be described further with the aid of the accompanying drawings which show one form of construction in accordance with the invention, by way of example.

Figure 1 is a side elevation of the apparatus for feeding the strip to be treated from a roll;

Figure 1A is a side elevation of the treating apparatus;

Figure 2 is a fragmentary view in front elevation, drawn to a larger scale;

Figure 3 is a partial section taken along a central vertical plane through the parts shown in Figure 2;

Figure 4 is a fragmentary sectional elevation;

Figure 5 is a longitudinal sectional elevation of a part of the apparatus, shown broken away; and

Figure 6 is a longitudinal sectional elevation of another part of the apparatus.

The apparatus illustrated is intended for the impregnation of paper with an insulating oil or compound and although it may be used for the impregnating and for the coating of materials other than paper with insulating oils or compounds or with other materials, the apparatus, for convenience, will be described in connection with the treatment of paper with an insulating oil.

Referring to Figure 1, a supply of the paper to be impregnated is formed into a roll 1 on a spindle 2 and the paper is drawn off from the roll as a sheet 3 under the control of a weight 70 acting upon a pulley wheel 71 fixed to the spindle 2. From the roll 1 the sheet passes behind a spring tension roller 4 and from the latter around a lower roller 5. The sheet 3 then passes upwards from the roller 5 around an upper roller 6 and from thence into a small vacuum tank 7. As will be seen from the figure the path of the sheet 3 around and between the rollers 5 and 6 approximates to that of a letter S. The two rollers are mounted one above the other and are placed closed to each other and the S shaped path of the sheet provides for a large area of contact between the sheet 3 and the two rollers. The upper roller 6 is mounted on a shaft 8 supported in bearings 9 and the lower roller 5 is mounted on a shaft 10 supported in bearings 11. The spindle 2 carrying the roll 1 and the shafts 8 and 10 are all carried between a pair of supports 12, Figure 1 showing one only of these supports.

The rollers 5 and 6 are free to rotate and are electrically heated for the purpose of drying the sheet 3 as it is drawn over those rollers and be-

fore it enters the vacuum tank 7. For this purpose the rollers 5 and 6 are provided with heating elements 13 in the form of fixed strips disposed inside the rollers. From the upper roller 6 the sheet 3 passes beneath a guide roller 15 which is mounted inside the vacuum tank 7, the front wall of the latter having a packed slot to permit the passage of the sheet. Between the place at which the sheet 3 leaves the upper roller 6 and the place at which the sheet runs on to the guide roller 15, the sheet travels in a horizontal plane.

The construction and arrangement of the packed slot referred to above will be seen by reference to Figures 2 and 3. In the latter figure, the numeral 16 represents the front vertical wall of the vacuum tank 7. The wall 16 has a horizontally disposed narrow slot 17, the length of which is substantially equal to the width of the sheet 3.

The slot 17 is packed to minimise the entry of air through the slot into the vacuum tank 7, by a pair of bars 20 and 21, the bar 20 being a fixed steel member and the bar 21 being adjustable and of rubber. The steel bar 20 is fixed to the wall 16 of the vacuum tank by studs 26 and nuts 27 and has a small groove in its underface to receive a rubber strip 28 which serves as a gasket to prevent air being drawn into the tank 7 between the bar 20 and the wall 16 of the vacuum tank 7. The rubber bar 21 is of angle shape in cross-section having a head 29 and a shank or stem 30 lying at right angles thereto. The head 29 is of substantial thickness and lies in contact with the wall 16 and is rigidly held in place by a bar 22 which extends horizontally across the wall 16, the upper edge of the bar 22 being recessed to receive the stem or shank 30 of the rubber bar 21. The latter is fixed rigidly to the bar 22 by a bar 80 and studs 18 which pass through the bars 22 and 80, and by nuts 19, and, as will be seen from Figure 3, the upper edge of the bar 22 provides an abutment for the head 29 of the rubber bar 21 so that the head is held in fixed relationship to the bar 22.

The rubber bar 21 is made adjustable by providing the bar 22 with a pair of brackets 23 fixed thereto at its ends by studs 31 and nuts 32. Each bracket has a threaded socket portion which receives the end of a screw 24 having a knurled operating knob 25. Vertical movement of the screws 24 is prevented by a pair of brackets 33 fixed to the wall 16 by studs 34 and nuts 35. Upon turning the screws by their knobs 25, the bar 22 and the rubber bar 21 are caused to recede from and approach the fixed steel bar 20. The two bars 20 and 21 are so arranged that when they are in contact their contacting surfaces coincide approximately with the longitudinal axis of the slot 17. When the sheet 3 lies in the slot 17 the metal bar 20 and the rubber bar 21 lie on opposite sides of the sheet and by adjusting the rubber bar 21 it can be brought into contact with the sheet and the latter pressed against the metal bar 20. After the rubber bar 21 has been adjusted, it is clamped down to bring its head 29 into firm contact with the wall 16 of the vacuum tank 7, by studs 37 and nuts 38, slots 36 in the bar 22 permitting the requisite sliding movement of that bar and of the rubber bar 21. By appropriate adjustment of the latter the leakage into the interior of the vacuum tank 7 while the paper sheet 3 is being drawn through the slot 17 can be reduced to a very small amount.

The tank 7 can be placed under vacuum by a

pump (not shown) connected to the tank by a pipe 40. The tank has a small cover 41 to enable the paper sheet 3 to be threaded up. The guide roller 15 mounted within the vacuum tank 7 may be heated electrically by heating elements 72 having the form of fixed strips, or the roller 15 may not be heated. If heated, however, the rate of heat supplied will be considerably less than the rate of heat supplied to the rollers 5 and 6 which serve to effect the major portion of the drying operation. If the roller 15 is not heated, the whole of the drying operation will be effected by the rollers 5 and 6 disposed outside the vacuum tank 7.

From the guide roller 15, the paper sheet 3 passes vertically upwards into an impregnating tank 42 having a cover 46. The impregnating tank 42 is smaller than the vacuum tank 7 and is mounted on top of the latter. Inside the latter are disposed guide rollers 44 and 45 and the sheet 3 passes upwards from the guide roller 15 through packed slots in the upper wall of the vacuum tank 7 and the bottom wall of the impregnating tank 42 and as soon as the paper sheet has passed through the slots it is brought into the body of insulating oil contained in the impregnating tank 42. This oil is maintained under atmospheric pressure and the sudden increase of pressure to which the paper sheet 3 is subjected gives rise to an impulsive type of impregnating action causing the oil to penetrate into the sheet. The guide rollers 44 and 45 ensure that the sheet is maintained in the body of insulating oil for thorough impregnation, the sheet passing vertically upwards from the guide roller 15 to the guide roller 44, round the latter and then vertically downwards to the second guide roller 45. From the latter the sheet 3 is drawn vertically upwards through the slot in the cover 46 on the impregnating tank 42. The sheet passes vertically upwards between a series of wipers 47 and over a small roller 48 and from thence over a roller 49 rotating in a bath of molten compound (not shown) so that one side 45 of the paper surface is coated with the compound which acts as a lubricating layer to facilitate the subsequent handling or working of the paper. If desired, however, the bath of compound may be omitted. From the roller 49 the sheet passes vertically downwards to a roller 50 from whence it passes upwards to a roller 51 and then downwards to a roller 52. From the latter the sheet again passes upwards to and is finally wound up on a roller 53.

The roller 53, a gear wheel 54 and a chain wheel 55 are mounted on a shaft 56. The roller 51 and a gear wheel 57 are mounted on a shaft 58. The roller 50 and a gear wheel 59 are mounted on a shaft 60 and the roller 52, a gear wheel 61, a chain wheel 62 and a pulley wheel 63 are mounted on a shaft 64. A gear wheel 65 drives wheel 54 and rotates the roller 53. The roller 52, wheel 61, chain wheel 62 and pulley wheel 63 are driven from the wheel 55 by a chain 66, wheel 61 meshing with wheel 57 and the latter with wheel 59. The roller 49 is driven from the pulley wheel 63 by a belt 68 which passes over a pulley 67, the roller 49 and pulley 67 being mounted on a shaft 69.

After the paper sheet 3 has been threaded up by hand, the impregnating tank 42 is filled with oil, the tank 7 placed under vacuum and the apparatus started up, the sheet being dried by the rollers 5 and 6 which are placed close to the vacuum tank, and then drawn through the latter

and from thence into the impregnant. The sheet is then dried and if desired is coated with the molten compound and finally wound up into a roll.

The slot in the bottom wall of the impregnating tank 42 is packed to minimise the leakage of oil from that tank into the vacuum tank 7.

Referring to Figure 4, the bottom wall 81 of the impregnating tank 42 has an aperture 82 of small width to permit the passage of the sheet 60 from the vacuum tank 7 into the tank 42. When the sheet has been passed through the aperture, a pair of india rubber blocks 83 are adjusted so that they make contact with the opposite sides of the sheet. The blocks 83 extend across the impregnating tank 42 and are secured to holders 84. The blocks 83 are brought into their proper positions by rotating screw threaded spindles 85 supported in brackets 86, the spindles 85 engaging with blocks 87 secured to the holders 84. The blocks are clamped in position by rotating box-nuts 88 which are engaged by throw-threaded bolts 90. The nuts 88 have long handles 89 to facilitate their operation. The upper wall of the tank 7 has an aperture 91 arranged opposite to the aperture 82.

It has been indicated above that the rollers 5 and 6 disposed outside the vacuum chamber 7 are electrically heated by elements having the form of strips 13 mounted inside the rollers. The heating means will now be described in greater detail with reference to Figure 5 of the drawings which shows the roller 5. The heating arrangements for the roller 6 are the same as those for roller 5.

The roller 5 is hollow and is free to rotate relative to the fixed shaft 8 by the provision of anti-friction bearings 92 adjacent each end of the shaft. The latter extends through the ends of the roller 5 and is supported in bearings 9 carried by brackets 93 fixed to the supports 12. The heating elements consisting of metal strips are mounted inside the roller 5 being fixed at their ends to insulating discs 94, the latter being carried by and fixed to the shaft 8. Terminal members 95 are fixed to one end of the strips and to these are connected insulated leads 96 which are taken out through an aperture 97 in the end of the shaft 8 to a junction box 98 provided with an external connection 99 for a cable 100.

It has been indicated above that the roller 15 disposed in the vacuum tank 7 may be heated by heating elements having the form of strips 72. Figure 6 shows in greater detail the heating arrangements for the roller 15 and reference will now be made thereto. The roller 15 is free to rotate upon a stationary shaft 101, being mounted upon anti-friction bearings 92. At one end, the left hand end of Figure 6, the shaft 101 is supported in a bearing 102 fixed to the wall 103 of the vacuum chamber 7 by studs 104. At the other end, the shaft 101 is tubular and has an aperture to enable the leads 105 connected to the strips 72 to be taken out through the end of the roller 15. The method of supporting the strips within the roller is the same as that shown in Figure 5. The tubular end of the shaft 101 is taken out through a plate 107 which closes an aperture in the wall 106 of the vacuum tank and is fixed to that wall. A vacuum tight joint is obtained between the plate and the shaft 101 by a gland 108, packing ring 109 and packing 110. The leads 105 are enclosed in a metal sheath 111 and a vacuum tight connection is obtained be-

tween the sheath and the shaft 101 by a gland 112 which is brazed to the sheath and screws into the end of the shaft, a joint ring 113 being placed between the gland and the shaft. The end of the cable is also sealed at 114. The ends of the leads 105 terminate in a junction box 115 to which the supply cables 116 are connected. The junction box is supported by and fixed to a casing 117, the latter being carried by brackets 118 fixed to the plate 107.

The improved arrangement has a number of advantages as compared with the apparatus described in Patent 1,958,984.

In the arrangement described above it will be observed that the drying rollers for the paper sheet are placed outside the vacuum tank and are readily accessible. This enables the apparatus to be worked with the drying rollers at a higher temperature since the paper is under better observation and control and attention to the paper is facilitated to avoid scorching in the event of stoppages. This enables the drying of the paper to be more complete and rapid. The practicability of more complete drying in this way permits the apparatus to be used for drying and impregnating sheet material of higher density than was practicable with the machine described in U. S. Patent 1,958,984. This is a particular advantage in preparing impregnated papers for use in building up the dielectric of electric cables, since higher density papers usually have superior electrical breakdown strength.

The improved arrangement also has the advantage of permitting the size of the vacuum tank to be reduced and the vacuum pump correspondingly reduced in capacity. The vacuum pump capacity is also greatly reduced by virtue of the fact that, since the paper is dried outside the machine, the water vapour emitted during the drying process does not pass through the vacuum pump. The removable cover for the vacuum tank is also comparatively small since it is only required to give access to the interior of the tank for the purpose of threading through the sheet material and for other simple operations before starting up the apparatus. The cover being small can be more easily handled and more readily secured. The construction of the vacuum tank is also simplified since it is not necessary to provide it with glands for the drying rollers or roll of paper or other material to be treated. It is also much easier to place a new supply of sheet material in position and thread it through the machine, so that the time of this operation is appreciably reduced. Similarly, if there is a break in the sheet this is more quickly repaired. The result is a greater output from a machine.

What we claim as our invention is:

1. An apparatus for the impregnation of sheet material comprising a vacuum tank having a slot in one of its walls, means for packing the slot, an impregnating tank in communication with the vacuum tank adapted to contain a body of impregnating liquid at a higher pressure than the pressure existing in the vacuum tank, members disposed outside the vacuum tank in the external atmosphere for effecting the major portion of the drying operation of the sheet material, means for heating said members, and means for drawing the sheet material into contact with those members and through the packed slot in the wall of the vacuum tank and from the latter directly into the body of impregnating liquid in the impregnating tank.

2. An apparatus for the impregnation of sheet

material comprising a support for a supply of the sheet material and at least two rollers and means for heating the rollers, the support and the rollers being disposed in the external atmosphere, the rollers serving to effect the major portion of the drying operation of the sheet material, a small vacuum tank having in one of its walls a slot, means for packing the slot, an impregnating tank on top of the vacuum tank adapted to contain a body of impregnating liquid at a higher pressure than that existing in the vacuum tank, at least one of said tanks having a slot placing the two tanks in communication, means for packing said slot, a guide roller in the vacuum tank for guiding the sheet material between the two packed slots and means for drawing the sheet material from the support into contact with the rollers outside the vacuum tank, through the packed slot in the wall of the vacuum tank, around the guide roller therein and through the second packed slot directly into the body of impregnating liquid in the impregnating tank.

3. An apparatus for the impregnation of sheet material comprising a small vacuum tank having a slot in one of its walls and means for packing the slot, a pair of rollers disposed adjacent

the wall of the vacuum tank having the slot, and means for heating those rollers, a support for a supply of the sheet material, the support and the pair of rollers being disposed outside the vacuum tank in the external atmosphere, a guide roller within the vacuum tank, means for heating the guide roller, an impregnating tank mounted on the vacuum tank adapted to contain a body of impregnating liquid at a higher pressure than that existing in the vacuum tank, at least one of said tanks having a slot placing the two tanks in communication and means for packing that slot, one of the pair of rollers outside the vacuum tank and the guide roller within that tank being so arranged that the sheet material occupies substantially a horizontal plane between those two rollers, and means for drawing the sheet material from off the support, around the pair of rollers outside the vacuum tank, through the packed slot in the wall adjacent the pair of rollers, around the guide roller in the vacuum tank and from thence through the second packed slot directly into the body of impregnating liquid in the impregnating tank.

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