Dec. 26, 1950 C. G. MUNTERS 2,535,087

APPARATUS FOR IMPREGNATING HEAT INSULATING MATERIAL

Filed July 20, 1945 2 Sheets-Sheet 1

Fig. 1.

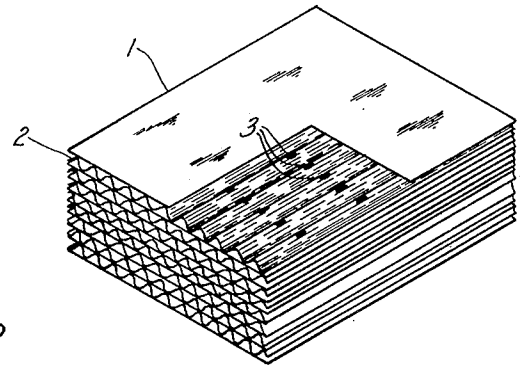


Fig. 2.

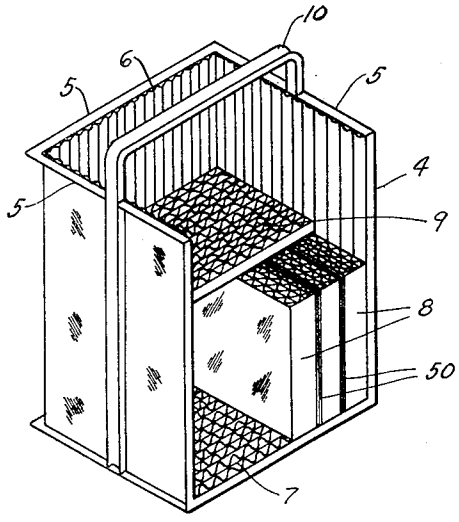


Fig. 3.

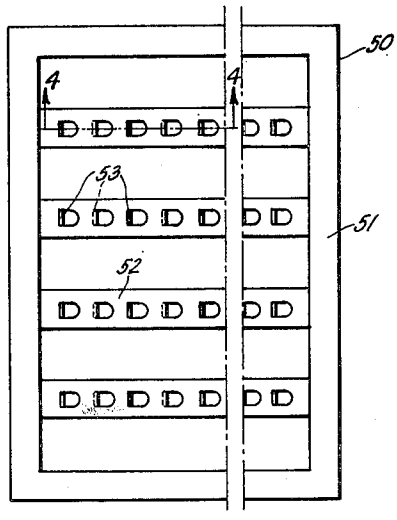
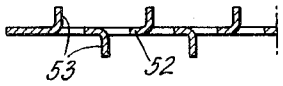


Fig. 4.



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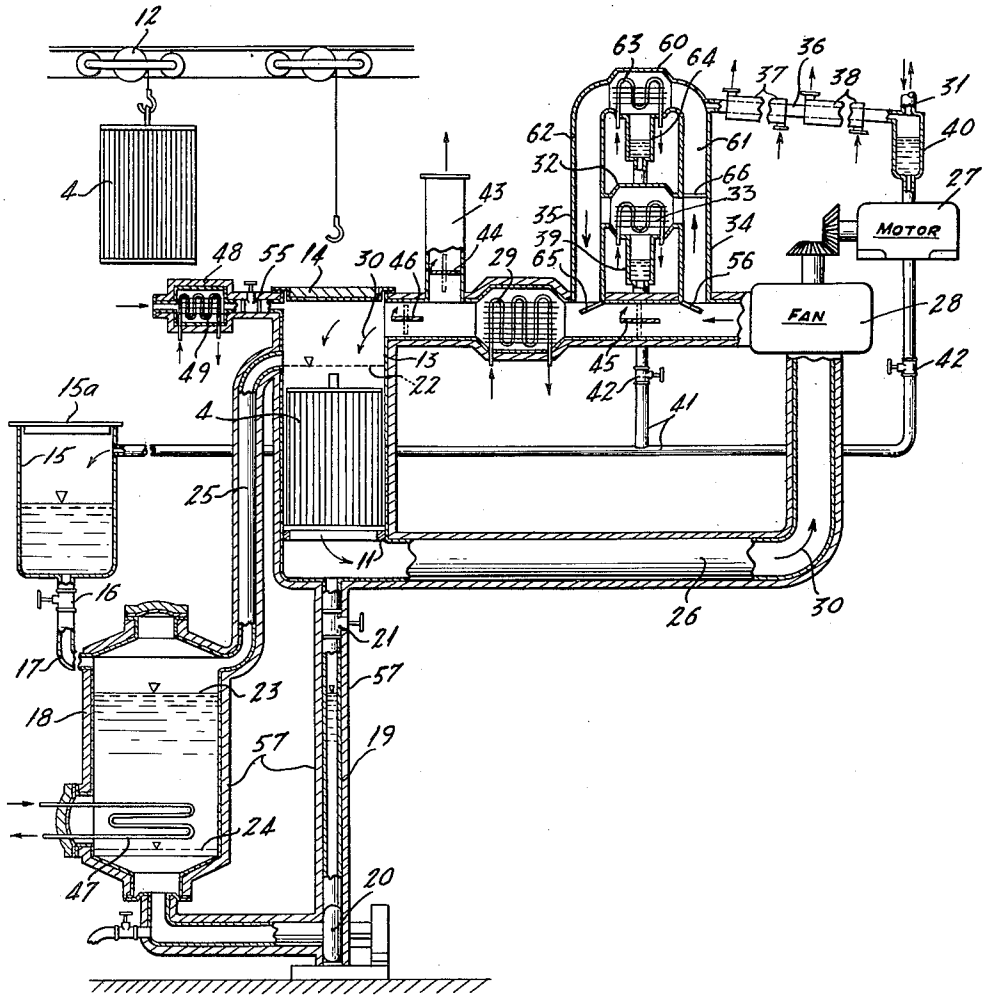
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APPARATUS FOR IMPREGNATING HEAT INSULATING MATERIAL

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Fig. 5.



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UNITED STATES PATENT OFFICE

2,535,087

APPARATUS FOR IMPREGNATING HEAT INSULATING MATERIAL

Carl Georg Munters, Stocksund, Sweden

Application July 20, 1945, Serial No. 606,199
In Sweden June 6, 1940

19 Claims. (Cl. 91—55)

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This application is a continuation in part of my copending application Serial No. 396,014, filed May 31, 1941, and now abandoned.

The present invention relates to apparatus for the manufacture of impregnated material of the kind to which the impregnating agent in a suitable solvent is applied and the solvent thereafter substantially removed to leave the material in its desired impregnated state. More particularly the invention relates to apparatus for impregnating units of heat insulating material of the multi-ply type having open ended inter-ply spaces.

The general object of the invention is the provision of improved apparatus whereby the material treated may be thoroughly impregnated, and dried by substantially complete removal of both solvent content and also moisture which may have been present in the material before treatment, while at the same time providing for recovery of a very high percentage of the solvent removed from the impregnated material. The above and other and more detailed objects, and the nature and advantages of the invention, will best be understood from a consideration of the ensuing portion of this specification and the accompanying drawings, which disclose by way of example but without limitation, suitable apparatus for carrying the principles of the invention into effect.

In the drawings:

Fig. 1 is a perspective view of a multi-ply insulation unit;

Fig. 2 shows a basket for dipping the insulating units into an impregnating bath;

Fig. 3 is an elevation on a somewhat enlarged scale of a portion of a distance member which is placed between the insulating units in the said basket;

Fig. 4 is a section on the line IV—IV of Fig. 3 on a still more enlarged scale;

Fig. 5 is a more or less diagrammatic view, partially in cross-section, of an apparatus according to the invention.

The multi-ply insulation shown in Fig. 1 preferably consists of a plurality of alternating plane and corrugated paper sheets 1 and 2, respectively, which prior to being impregnated according to the invention are united with each other by means of a suitable binding agent, such as water glass. The binding agent may be applied to the corrugations along the entire length thereof, a comparatively strong binding of the various sheets being attained thereby. In most cases it is sufficient, however, to interconnect the

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sheets at points only, as indicated at 3 in Fig. 1.

Preparatory to being impregnated in the apparatus in accordance with the invention, a number of insulating units 8 (Fig. 2) are disposed within a sheet-metal basket 4. This basket may have three side walls 5 covered on the inside thereof with corrugated sheet-metal 6. This sheet-metal has for its object to facilitate the penetration of the impregnating agent between the insulating units and the walls of the basket and to prevent the units from sticking to the walls. Instead of corrugating the sheet-metal members 6 they may be provided with projections or punched-out tabs, thus reducing the number of points of contact between the units and the basket. The insulating units 8 are inserted in one or more layers into the basket 4 so as to fill up the whole cross section thereof (for sake of clearness only a few insulating units have been illustrated in Fig. 2). It is important always to place the insulating material in a manner such that the ends of the channels between the paper sheets will be open, said passages extending in a generally vertical direction. The bottom of the basket is perforated and may consist of a grid 7 of sheet-metal strips. These strips are placed edgewise, and are of a suitable height in a vertical direction, so that the outflow of impregnating agent from the lower portions of the boards is facilitated after the dipping operation. In the embodiment illustrated all corrugations of the various sheets 2 are parallel to one another, the sheets being arranged with the corrugation channels at right angles to the bottom grid 7. A sheet-metal grid 9 may be placed between consecutive units and on top of the uppermost unit 8 in the basket 4, said grids serving to load the insulating material and to keep the same in the proper position during impregnation. Furthermore, distance members 50 may be provided between the units 8, said distance members being preferably formed by sheet-metal ribs 52 (Figs. 3 and 4) extending between a frame 51, said ribs being provided with punched-out projections 53 bent outwardly on both sides and bearing against the units bearing at spaced points so as to prevent warping of the units during the treatment thereof.

The basket 4 filled in the manner above described and provided with a strap 10 is then conveyed, for instance, by means of an overload conveyor system 12, to an impregnating chamber 13, into which the basket is introduced through an opening which is closed by means of a cover 14 during the impregnation procedure. The cham-

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ber 13 is about of the same rectangular cross section as that of the basket 4 and furthermore, means, such as supporting ribs 14, are provided for the basket, to close any passages between the walls of the basket and the chamber. In a mixing container 15, which is normally closed by means of a cover 15a, a mixture is prepared of impregnating agent and solvent, preferably relatively refractory asphalt and tri-chloro-ethylene. A suitable quantity of this mixture is supplied to a receptacle 18 through a conduit 17 having a valve 16. The receptacle 18 may be equipped with a heating device 47, for instance in the form of a pipe coil for heating the liquid mixture. The lower portion of the receptacle 18 communicates through a conduit 19, in which is provided a pump 20 and a valve 21, with the lower portion of the chamber 13. When the pump 20 is started and the valve 21 is open, the liquid impregnating agent dissolved in solvent is pumped up from the receptacle 18 through the conduit 19 into the chamber 13 to a level 22 above the basket 4. At the same time, the liquid level falls in the receptacle 18, for instance from a level 23, which is below the bottom of the chamber 13, to a level 24. Connected to the chamber 13 is the upper end of an overflow conduit 25, the lower end of which opens into the receptacle 18, and which prevents the liquid from rising too high in the chamber 13. The upper and lower portions of the chamber 13 communicate with a circulation passage 26 which will also be partly filled with liquid, as will appear from Fig. 5. Owing to the construction of the basket 4 and the arrangement of the passages of the insulating units as above described, the liquid mixture will readily penetrate into the insulating material. After the insulating material has become impregnated to the desired extent, the liquid in the chamber 13 and in the passageway 26 is caused to flow back by gravity to the receptacle 18, by stopping the pump 20.

In the upper portion of the passage 26, above the highest level which the liquid rises in the passage, there is a powerful fan 28, driven by a motor 27. In the passage between the fan and the upper end of chamber 13 there is located a heater 29. The fan 28 sets up a circulation of vapours and air within the chamber 13 and the passage 26, in the direction indicated by the arrows 30. The heater 29 necessarily introduces resistance to flow of the gaseous medium circulated by the fan 28 with the result that when the apparatus is in operation the closed circuit is in effect divided into two sections, one of which, between the fan and the heater, is at superatmospheric pressure, and the other of which, on the suction side of the fan and including chamber 13, is at subatmospheric pressure. Other means, such as dampers 46, 56, 65, hereinafter described, may provide additional resistance to flow but these are on the inlet side of chamber 13 which remains in the low pressure section of the circuit subject to fan suction. A condenser 32 provided with a water-cooled element 33 is connected by means of conduits 34 and 35 in parallel to that portion of the circulation passage 26 which is located between the fan 28 and the heater 29. A further condenser 60 is connected in parallel to the condenser 32 by extensions 61 and 62 of the conduits 34 and 35, respectively. The condenser 60 contains means, such as an element 63, which is cooled with liquid from a refrigerating machine, of known type (not shown), so that the temperature in the condenser 60 is appreciably lower than that in the condenser 32. Extending from the condenser 60 is a conduit 36 which is preferably cooled by means of two condensers 37 and 38, and which opens through a conduit 31 into the atmosphere. The one condenser 37 is preferably cooled with water from the service system, and the other is cooled with cooling liquid from a refrigerating machine. If desired, the conduit 31 may have an absorber, containing active carbon, for example. Furthermore, a suction fan may be arranged in the conduit 31, said fan creating a small pressure below atmospheric within the circulation system, sufficient to prevent leakage of vapour therefrom. The volumetric capacity of the fan may be small for the purpose in view. The condenser 32 and 60, and the conduit 36 are provided with collecting receptacles 39, 64 and 49, respectively, for condensate, which is returned to the container 15 through conduits 41, which may have valves 42. Furthermore, the upper portion of the circulation passage 26 is provided, between the heater 29 and the impregnating chamber 13, with a pipe connection 43 leading to the atmosphere, said pipe connection having a damper 44. Similar dampers are provided in the circulation passage 26 between the condenser conduits 34 and 35 on the one hand and between the pipe connection 43 and the chamber 13 on the other hand, as indicated at 45 and 46, respectively. In the condenser conduit 34 there is arranged a damper 55, and in the conduit 35 a damper 65. A damper 66 is provided between the conduit 34 and its extension 61.

Fresh air may be taken in to the impregnating chamber 13 through a passage 48 having a heater 49 and a valve member 55. As will be seen from Fig. 5, such parts of the apparatus that may be subjected to heat are surrounded by an insulating layer 57.

After the insulating units in the basket 4 have been soaked with solvent and impregnating agent, valve 21 is opened to permit the liquid to flow by gravity to the receptacle 18, the fan 28 is started, and heat is supplied to the heater 29. It may happen that an unnecessarily large quantity of said liquid remains in the paper insulation, particularly when the spacing of the plane paper sheets is small, on account of the capillary effect. Such an excess of liquid is blown, to begin with, from the insulation by means of the downflowing air current produced by the fan, and is caused to flow back to the conduit 19.

The circulation system has for a substantial object to remove the solvent from the insulating units and to recover the same after the impregnation procedure. This may then be effected in the following manner. The damper 44 and the valve member 55 are closed while the damper 46 is open. The dampers 45, 56 and 65, are adjusted so that a certain portion of the air and vapours brought into circulation by the fan 28 always passes through the condenser 32, while the passage through the extension 61 is closed. The air flowing through the insulating units and heated by the heater 29 induces an evaporation of the solvent and carries the same along in the circulation. The circulating air is prevented from being saturated with solvent by the fact that a certain portion of the same always passes through the condenser 32 where the solvent is condensed and flows into the receptacle 39. The air cooled down within the condenser 32 is heated again by

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the heater 29 prior to its passing through the channels of the insulating units. Inasmuch as the condenser 32 is always in open communication with the atmosphere through the conduit 36, the same pressure will always be maintained in the system of circulation, that is substantially atmospheric pressure or a somewhat lower pressure, if a suction fan is connected to the conduit 31 as above stated. Any gaseous solvent, which passes with air through the conduit 36 by reason of the evaporation of the solvent and by the increase of the volume caused thereby within the system of circulation, is condensed in the condensers 60, 37, 38 or is absorbed by the abovementioned absorber. After some time the damper 66 is adjusted so that it opens communication between the conduits 34 and 61 and cuts off the condenser 32. The gas circulating through the conduits 34, 61, 62 and 35 is now cooled down in the condenser 60 to a lower temperature than in the condenser 32, and consequently the partial pressure of the solvent is decreased so that it is evaporated from the insulating units and condensed from the gas circulating in the passageway 26 in a very effective manner. The most of the solvent is deposited in the condenser 32 which increases the economy of the apparatus and reduces the required capacity of the refrigerating machine above referred to. The condensate flows from the containers 39, 40 and 64 through the conduits 41 back to the collecting receptacle 15.

After the liquid has been drawn off the chamber 13, solvent is evaporated so as to saturate the air within the channels of the units. Before the fan 28 is started, no further evaporation can thus take place, by reason of which the viscosity of the liquid is maintained and the outflow of liquid from the interior of the units continues. It is evident that the quantity of impregnating agent remaining in the insulation may be varied by starting the fan and the process of condensation at different time intervals from the moment the chamber 13 is emptied. It will frequently be found advantageous to commence the circulation and the condensation processes immediately after the liquid has been drawn off. The quantity of asphalt may preferably amount to 35–60 per cent of the weight of the finished insulation.

The circulation continues in the manner above described, while the temperature of the circulating mixture of air and vapour rises higher and higher and the relative degree of saturation of the circulating air becomes smaller and smaller, until the major portion of the solvent has been removed from the paper insulating units and has been returned to the container 15 from the condensers 32, 37, 38 and 60 respectively. The solvent is thus recovered practically in its entirety.

In certain cases, particularly if the solvent has a relatively low boiling point, the removal of the same from the insulating units may take place by boiling the solvent out of the same directly. The system of circulation will then substantially only contain vapour of the solvent, which penetrates into the condensers 60, 37 and 38, respectively, wherein the same is condensed. In this case the damper 56 may thus be closed. Otherwise, however, the circulation takes place in the same manner as above described for the supply of heat from the heater 29 to the paper units. The last part of the solvent is preferably removed from the circulating gas and the insulating units and recovered in the same manner as above described.

It may be of value to dry the paper insulation accurately prior to the impregnation process. As is well known, air-dry paper normally contains 5–10% of moisture, which may be sufficient to render the penetration of the impregnating agent into the pores and fibres of the paper difficult. It is desirable, therefore, to expel this moisture in order to attain the best possible impregnation. Furthermore, if the impregnation takes place at a relatively high temperature, the paper insulation may be damaged by the vapour developed during the dipping procedure unless the insulation has been completely dried before. The drying of the paper insulation may of course be effected before it is introduced into the impregnation chamber.

This drying, however, may advantageously be undertaken in the impregnating chamber 13, which is closed by the cover 14 after the insulation is introduced. The dampers 44 and 65 are kept closed, while the dampers 45, 56 and 46 are open. Heating medium is admitted to the heater 29, and the fan 28 is started. Circulation of hot air will then be obtained through all passages of the insulating material, the moisture of the paper being taken up by the air. In this connection it might be desirable to open the valve member 55 to some extent, so that a certain percentage of fresh air is always taken into the system of circulation, whereas a corresponding quantity of air saturated with moisture is expelled through the conduits 34, 61 and 36.

The apparatus above described may also be used for the impregnation of paper insulations with impregnating agents in an emulsified state, for instance with an asphalt emulsion consisting of asphalt and water, the asphalt being contained therein in a very finely divided state. The impregnation takes place in a similar manner as previously described by pumping up the asphalt emulsion from the container 18 to the impregnation container 13, whereupon, after the impregnation has been performed, the rest of the emulsion is caused to flow back to the container 18. The evaporation of the water from that portion of the emulsion which has been absorbed by the paper insulation is preferably effected in a similar manner as above described for the drying of the insulation prior to the impregnation process.

The impregnation having been effected, particularly with the use of an asphalt emulsion, it may be found desirable to heat the insulation to a relatively high temperature, the impregnating agent being then melted into the paper sheets so as to soak them completely, so that the best possible impregnating effect will be obtained. This heating and melting-in procedure is also effected readily and efficiently by the system of circulation shown in Fig. 5. The dampers 44, 56 and 65, respectively, and the valve 55 are then kept closed, whereas the dampers 45 and 46 are open, heating medium being supplied to the heater 29, and the fan 28 being started. In certain cases an oxidation of the asphalt may take place at the same time, the air being then preferably renewed during the circulation in the system by adjusting the dampers 55, 46 and 44 accordingly.

It may occur that a certain smell from the solvent still remains in the paper insulation after impregnation. To remove this smell, fresh air should preferably be circulated through the in-

sulation, which may be effected by removing the cover 14 from the chamber 13, the damper 46 being closed and the damper 44 opened. The fan 28 will then suck a current of fresh air through the paper insulation, which air is then blown out through the passage 43 to the atmosphere. By this procedure the units are also cooled down.

The apparatus according to the invention as hereinbefore described has the advantage that the whole procedure of impregnating the paper insulation is effected within a closed system. This facilitates recovery of the greatest possible quantity of solvent by avoiding all losses that would otherwise ensue during the transfer of the impregnated insulation from one container to another. This will obviously be found valuable, since most solvents are comparatively expensive. The closed system is also of great advantage in those cases where the impregnating agents are inflammable or have detrimental physiological effects on the operator of the plant. By the fact that the drying, impregnation, evaporation and so forth is effectd with the introduction of the insulation into one and the same container without any reloadings, the attendance is obviously also simplified, with a saving of time and cost in consequence thereof.

The asphalt used for the impregnation is preferably of a kind having its softening point, determined by means of the known ball and ring method, between 95–150° C. and even preferably still higher.

While a more or less specific embodiment of the invention is described, it is to be understood that this has been done for purposes of illustration only and that the invention is not to be limited thereto but its scope is to be determined by the appended claims.

What I claim is:

1. In an apparatus for treating material with an impregnating agent dissolved in a solvent, means forming a continuous passageway providing a closed circuit, a portion of said passageway forming a chamber for receiving material to be treated, means for producing flow of gas through said passageway including said chamber, means for heating the gas before introduction into said chamber, a part of said passageway in advance of said heating means being divided into parallel paths, means for varying the flow of gas through the respective paths, a condenser associated with each of said paths, and means for maintaining one of said condensers at a lower temperature than the other.

2. In an apparatus for treating material with an impregnating agent dissolved in a solvent, means forming a continuous passageway providing a closed circuit, a portion of said passageway forming a chamber for receiving material to be treated, a receptacle for containing a liquid comprising said agent dissolved in said solvent, means for transferring liquid between said receptacle and said chamber, means for producing flow of gas through said passageway including said chamber, means for heating the gas before introducing it into said chamber, a condenser connected to said passageway in advance of said heating means for receiving gas which has passed through said chamber, means for conveying gas from said condenser to the exterior of said closed circuit to prevent the gaseous pressure in said circuit from rising above substantially atmospheric pressure, and condensing means for removing solvent vapor from gas passing through the last mentioned means.

3. In an apparatus for treating material with an impregnating agent dissolved in a solvent, means forming a continuous passageway providing a closed circuit, a portion of said passageway forming a chamber for receiving material to be treated, said chamber communicating with said passageway through an inlet in the upper portion of the chamber and an outlet located in the lower portion of the chamber, a receptacle located at a lower level than said chamber for containing a liquid comprising said agent dissolved in said solvent, a conduit connecting the lower part of said chamber with said receptacle, a pump for transferring said liquid from said receptacle through said conduit to said chamber, means for producing flow of gas through said passageway to flow downwardly through said chamber from said inlet to said outlet, means for heating the gase before introducing it into said chamber, a condenser connected to said passageway in advance of said heating means for receiving gas which has passed through said chamber, and means for conveying gas from said chamber to the exterior of said closed circuit.

4. Apparatus for treating material with a solution of an impregnating agent contained in a solvent comprising a treating chamber, a tank for the storage of said solution, interconnected conduits between said treating chamber and said storage tank providing a closed liquid circuit with said treating chamber, conduit means providing a closed gas circuit with said treating chamber, a pump for producing movement of the solution in said liquid circuit to thoroughly wet and treat material disposed in said treating chamber, a fan for producing movement of gas in said gas circuit including movement of gas through said treating chamber, the conduits forming the liquid and gas circuits connecting to the treating chamber at the bottom of the same to provide for concurrent flow in downward direction through the chamber of the gas and excess solution during the operation of the apparatus, a heater in said gas circuit, a plurality of conduits communicating with said gas circuit in advance of said heater, a plurality of condensers connected between said conduits to condense solvent contained in said gas, means for maintaining one of said condensers at a temperature lower than that maintained in the other condenser, means for collecting condensate from each condenser and returning the same to said tank, a vent for releasing gas to the atmosphere from said gas circuit, condensing means associated with said vent for condensing solvent from the gas prior to venting thereof, means for collecting solvent thus condensed and returning same to said tank, and means for selectively controlling the volume of gas flowing in said gas circuit and through each of said condensers whereby the impregnated material may be dried and substantially all of the solvent present therein at the completion of the impregnating operation recovered prior to removal of the impregnated material from said chamber and means whereby said material may be cooled prior to removal thereof from said chamber.

5. Apparatus for treating material with a solution of an impregnating agent contained in a solvent comprising a treating chamber, a tank for the storage of said solution, interconnected conduits between said treating chamber and said storage tank providing a closed liquid circuit with said treating chamber, conduit means providing a closed gas circuit with said treating chamber, means for producing movement of the solution

in said liquid circuit to thoroughly wet and treat material disposed in said treating chamber, means for producing movement of gas in said gas circuit including movement of gas through said treating chamber, the conduits forming the liquid and gas circuits connecting to the treating chamber at the bottom of the same to provide for concurrent flow in downward direction through the chamber of the gas and excess solution during the operation of the apparatus, a heater in said gas circuit, a plurality of conduits communicating with said gas circuit in advance of said heater, a plurality of condensers connected between said conduits to condense solvent contained in said gas, means for maintaining one of said condensers at a temperature lower than that maintained in the other condenser, means for collecting condensate from each condenser and returning the same to said tank, and means for selectively controlling the volume of gas flowing in said gas circuit and through said condensers whereby the impregnated material may be dried and substantially all of the solvent present therein at the completion of the impregnating operation recovered prior to removal of the impregnated material.

6. Apparatus for treating material with a solution of an impregnating agent contained in a solvent comprising a treating chamber, a tank for the storage of said solution, interconnected conduits between said treating chamber and said storage tank providing a closed liquid circuit with said treating chamber, conduit means providing a closed gas circuit with said treating chamber, means for producing movement of the solution in said liquid circuit to thoroughly wet and treat material disposed in said treating chamber, means for producing movement of gas in said gas circuit including movement of gas through said treating chamber, the conduits forming the liquid and gas circuits connecting to the treating chamber at the bottom of the same to provide for concurrent flow in downward direction through the chamber of the gas and excess solution during the operation of the apparatus, a heater in said gas circuit, a plurality of condensers in said gas circuit for treating gas passing therethrough, means for maintaining said condensers at substantially different temperatures for producing stage removal of solvent from the gas circulating in the circuit, the second condenser being adapted to be brought into operation only when increased condensation is required.

7. Apparatus for treating material with a solution of an impregnating agent contained in a solvent comprising a treating chamber, a storage means for said solution, means including conduits respectively connecting said storage means with the upper and lower portions of said chamber for flow of said solution from the storage means to the chamber and return to the storage means, means for causing flow of said solution from said storage means to said chamber to thoroughly wet and treat material disposed in the chamber and for causing return flow to the storage means of the solution from said chamber through the one of said first mentioned conduits connected with the lower portion of the chamber to drain the latter, conduit means including a gas supply conduit communicating with the upper portion of said chamber and a gas return conduit communicating with the lower portion of the chamber, said conduit means and said chamber providing a closed circuit for circulation of gas, means for circulating gas through said circuit in a direction such that it flows downwardly through said chamber, a heater in said gas circuit in advance of said chamber, a plurality of condensers in said gas circuit for treating gas passing therethrough, means for maintaining said condensers at substantially different temperature for removal of solvent from the gas circulating in the circuit and means for returning solvent removed by said condensers to said storage means.

8. In apparatus for treating material with an impregnating agent dissolved in a solvent, means forming a continuous passageway providing a closed circuit, a portion of said passageway including a chamber for receiving material to be treated, means for producing flow of gas through said passageway including said chamber, means for heating the gas prior to introducing the gas into said chamber to cause the gas to remove solvent in vapor form from material in said chamber, a plurality of conduits communicating with said passageway in advance of said heating means, a plurality of condensers connected between said conduits to condense said vapors, one of said condensers being water cooled whereby to be maintained at a temperature above the freezing point of water and the other condenser being cooled by a refrigerant whereby to be maintained at a temperature below the freezing point of water, reservoir means for condensate, means for collecting condensate from each condenser and returning the same to said reservoir means, and means for selectively controlling the volume of gas flowing in said passageway and through said condensers whereby the impregnated material may be dried and substantially all of the solvent present therein at the completion of the impregnating operation recovered prior to removal of the impregnated material.

9. In apparatus for treating material with an impregnating agent dissolved in a solvent, means forming a continuous passageway providing a closed circuit, a portion of said passageway including a chamber for receiving material to be treated, means for producing flow of gas through said passageway including said chamber, means for heating the gas prior to introducing the gas into said chamber to cause the gas to remove solvent in vapor form from material in said chamber, a plurality of conduits communicating with said passageway in advance of said heating means, a plurality of condensers connected between said conduits to condense said vapors, means for maintaining one of said condensers at a temperature lower than that maintained in the other condenser, reservoir means for condensate, means for collecting condensate from each condenser and returning the same to said reservoir means, and means for selectively controlling the volume of gas flowing in said passageway and through said condensers whereby the impregnated material may be dried and substantially all of the solvent present therein at the completion of the impregnating operation recovered prior to removal of the impregnated material.

10. In apparatus for treating material with an impregnating agent dissolved in a solvent, means forming a continuous passageway providing a closed circuit, a portion of said passageway forming a chamber for receiving material to be treated, means for producing flow of gas through said passageway including said chamber, means for heating the gas prior to introducing the gas into said chamber to cause the gas to remove solvent in vapor form from material in said chamber, a plurality of conduits com-

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municating with said passageway in advance of said heating means, condensing means connected between said conduits to condense said vapors, reservoir means for condensate, means for collecting condensate from said condensing means and returning the same to said reservoir means, a vent for venting gas to the atmosphere, condensing means associated with said vent for condensing solvent from the gas prior to its being vented, means for collecting solvent thus condensed, and means for selectively controlling the volume of gas flowing in said passageway and through said condensing means whereby the impregnated material may be dried and substantially all of the solvent present therein recovered at the completion of the impregnating operation prior to removal of the impregnated material.

11. In apparatus for treating material with an impregnating agent dissolved in a solvent, a treating chamber, means providing a closed circuit for solvent containing gas including said chamber, means for circulating gas through said circuit, heating means for the gas in said circuit, a plurality of spaced condensers in said circuit for removing solvent from said gas, and means whereby said condensers may be selectively employed for removing solvent from the said gas in said circuit.

12. In apparatus for treating material with an impregnating agent dissolved in a solvent, a treating chamber, means providing a closed circuit for solvent containing gas including said chamber, means for circulating gas in said circuit, heating means for the gas in said circuit, a plurality of spaced condensers in said circuit for removing solvent from the gas, means for permitting flow of excess gas from the circuit to prevent the gaseous pressure in the circuit from exceeding substantially atmospheric pressure and means cooperating with the last mentioned means for recovering the solvent content of said excess gas.

13. In apparatus for treating material with an impregnating agent dissolved in a solvent, a treating chamber, means providing a closed circuit for solvent containing gas including said chamber, means for circulating gas through said circuit, heating means for the gas in said circuit, a plurality of spaced condensers in said circuit for removing solvent from the gas, means whereby said condensers may be selectively employed for removing solvent from the gas in said circuit, a vent for said circuit, and condensing means for removing solvent from the gas passing to said vent.

14. In apparatus for treating material with an impregnatng agent dissolved in a solvent, a treating chamber, means including said chamber providing a closed passageway including a main circuit and an auxiliary circuit for solvent containing gas, means for circulating the gas through said passageway, heating means for the gas in said passageway, a plurality of spaced condensers in said passageway for removing solvent from the gas, said auxiliary circuit including one of said condensers, and means for supplying cooling media at materially different temperatures to different condensers.

15. In apparatus for treating material with an impregnating agent dissolved in a solvent, a treating chamber, means providing a closed circuit including said chamber for solvent containing gas, means for circulating gas through said circuit, heating means for the gas in said circuit, a plurality of spaced condensers in said circuit for removing solvent from the gas, and a by-pass conduit for withdrawing gas from said circuit and including a condenser for removing solvent from said gas.

16. In apparatus for treating material with an impregnating agent dissolved in a solvent, a treating chamber, means providing a closed circuit including said chamber for solvent containing gas, means for circulating gas through said circuit, heating means for the gas in said circuit, a plurality of spaced condensers in said circuit for removing solvent from the gas, one of said condensers being cooled with water and the second with a refrigerant and with the second condenser refrigerated at a temperature below the first.

17. In apparatus for treating material with an impregnating agent dissolved in a solvent, a treating chamber, means providing a closed circuit for solvent containing gas including said chamber, means for circulating gas through said circuit, heating means for gas in said circuit, condensing means in said circuit for removing solvent from said gas, means for permitting flow of excess gas from the circuit to prevent the gaseous pressure in the circuit from exceeding substantially atmospheric pressure and means cooperating with the last mentioned means for recovering the solvent content of said excess gas.

18. In apparatus for treating material impregnated with an agent dissolved in a solvent, means providing a treating chamber for the material, said chamber having a gas inlet and a gas outlet, conduit means connected with said inlet and said outlet and providing with said chamber a closed circuit for circulation of gas, means in said circuit for circulating gas through the circuit, means located in said circuit between the discharge side of said circulating means and the gas inlet of said chamber for producing resistance to flow of the gas to the chamber, whereby to provide a first section in said circuit of superatmospheric pressure in said circuit on the discharge side of the circulating means and a second section in said circuit of subatmospheric pressure created by the suction of said circulating means, said second section including said chamber, an inlet providing communication between said circuit and the ambient atmosphere at a place located in said second section on the inlet side of said chamber for admitting air to the circuit, an atmospheric vent communicating with said circuit at a place located in said first section, and condensing means located to be traversed by and to remove solvent from gas flowing from said first section to said atmospheric vent.

19. In apparatus for treating material with an impregnating agent dissolved in a solvent, means including a chamber providing a closed circuit for solvent containing gas, means for circulating gas through said circuit, said chamber being located on the suction side of said circulating means to be maintained thereby at subatmospheric pressure, heating means for the gas in the circuit located between said circulating means and said chamber, means for admitting air to said chamber to mingle with the gas circulating in said circuit, conduit means communicating with said circuit between said circulating means and said heating means for flow of excess gas from the circuit to prevent rise of gaseous pressure in the circuit above substantially atmospheric pressure, and condensing

means in said conduit means for condensing solvent vapor from the gas passing therethrough.

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