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PROCESS OF IMPREGNATING WOOD AND THE LIKE

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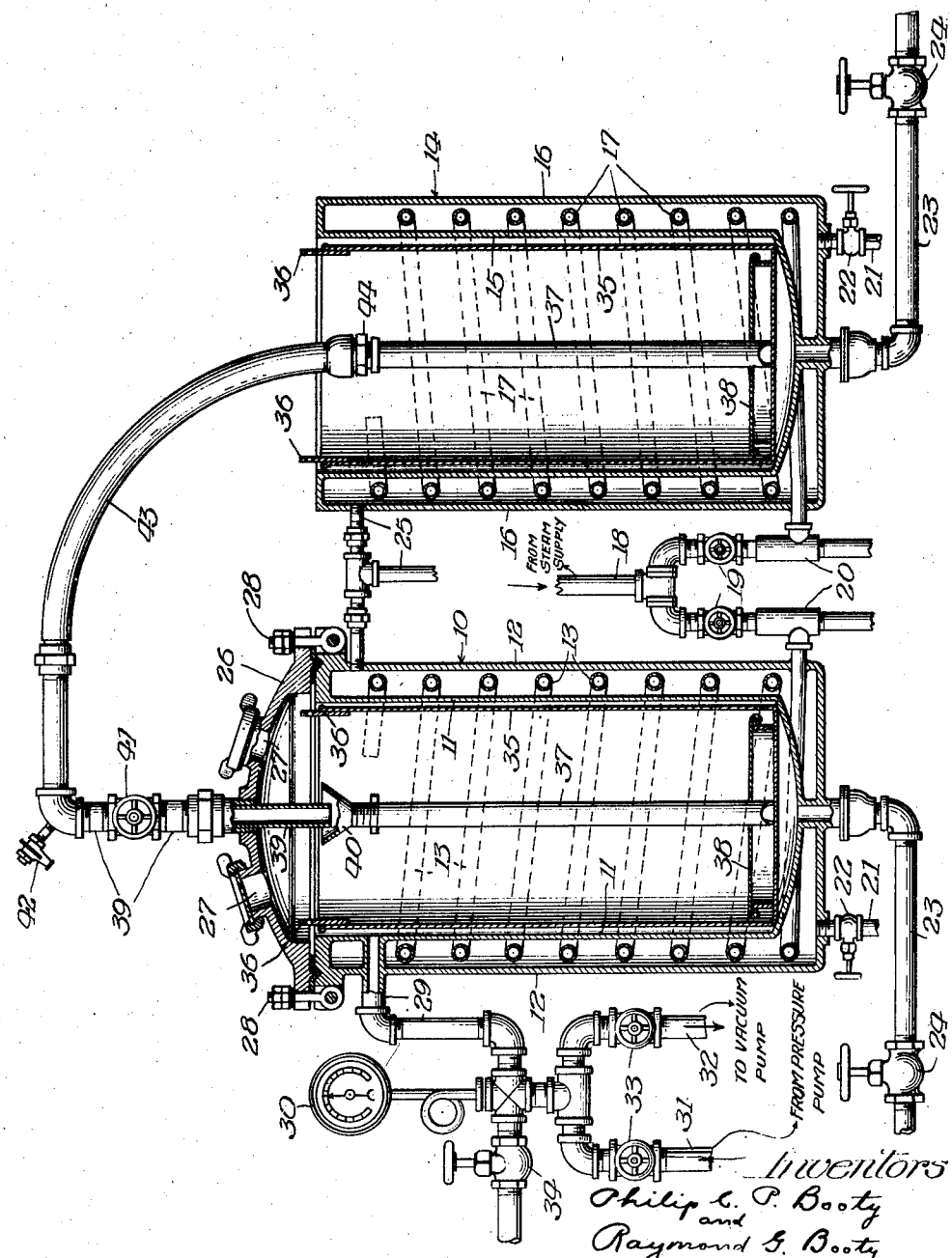

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PROCESS OF IMPREGNATING WOOD AND THE LIKE

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6 Claims. (Cl. 21—49)

Our invention relates to an improved process of impregnating wood and the like whereby the pores of the wood may be filled with a resinous material which will harden and become insoluble in the pores so as to give the finished product highly improved qualities with respect to strength, resiliency, texture, finish and durability, and so as to give it a high degree of protection with respect to destruction by fire or deterioration by contact with moisture, as well as to make it more effectively insulating and to make it more readily workable without splitting.

It is one of the objects of our invention to provide an improved process of introducing a suitable impregnating material into the wood whereby the impregnation may be effected easily and quickly at a minimum expense and with assurance that the impregnating operation will be successful for producing the desired qualities with substantially no likelihood of failure.

To these ends, it is an object of our invention to provide an improved process comprising a suitable sequence of steps, all within easy control of an operator and capable of being carried out readily upon a commercial basis, by which a suitable impregnating material may be introduced into the wood and hardened in the pores without the use of applied pressure during the hardening step and without danger that the treated articles will be ruined by frothing or by any other unexpected cause. In this connection it is an object of our invention to provide an improved impregnating material of such character that a fairly accurate practice of our improved process, including the use of such improved impregnating material, upon a commercial scale by a careful operator will insure a high degree of success with respect to the final product.

A further object of our invention is to provide an improved process as above set forth and having the advantages mentioned in which a suitable condensation material preferably of the phenol-formaldehyde type is introduced into the pores of the articles by means of a suitable liquid vehicle including an agent adapted to retard polymerization of the resinous material, in which the liquid vehicle and the agent are separated from the resinous material in their liquid phase by the application of heat and under substantially normal atmospheric pressure without causing the resinous material to froth or boil out of the pores and to accumulate on the outside surfaces of the articles, and in which after such separation and the continued application of heat under said pressure conditions polymerization of the resinous material proceeds and it is cured in the pores of the articles.

The step of introducing the resinous material into the pores of the articles is preferably carried out by placing the articles, preferably under a high vacuum, in a solution comprising the resinous material, the liquid vehicle and the retarding agent as aforesaid for a short time and then, particularly if deep penetration is desired, under air pressure substantially above atmospheric, and in so doing some of the resinous material accumulates or builds up on the outside surfaces of the articles so treated. It is another object of our invention to effect a removal of such surplus material in such manner that the major portion at least of the material so removed will be recovered so that it may be again used in the process.

It is another object of our invention to improve processes of this type in sundry details hereinafter pointed out. That which we believe to be new and desire to cover by Letters Patent is set forth in the claims.

The drawing shows diagrammatically one arrangement of apparatus by which certain steps of our improved process may be carried out.

The apparatus shown in the drawing is not claimed in this application, but forms the subject-matter of our copending application Serial No. 15,898, filed of even date herewith.

Our invention has been worked out particularly with reference to the impregnation of wooden articles, although it is believed to be applicable generally to the impregnation of articles made from fibrous materials other than wood. The invention is described herein with respect to articles of wood, in the treatment of which the process has been found to be of substantial importance.

The base material employed in our process preferably comprises a phenol-formaldehyde resin adapted to harden readily under proper conditions into an insoluble mass. As is well known, when phenol and formaldehyde are reacted in the presence of a suitable catalyst, condensation occurs and in addition to the condensation product which results, water is also formed. Upon continued heating, the molecules of the condensation product tend to aggregate or polymerize into still larger particles depending upon the proportions in which the base materials have been used, the temperature employed and the time the reaction is allowed to proceed. It is also known that a large proportion of formaldehyde favors the formation of larger aggregates

and in view of that fact a material made by the use of a relatively large amount of formaldehyde generally is not as satisfactory for the impregnation of articles of wood as one in which the molecules are of smaller dimensions. It is obvious that the larger the molecules of the resinous material the more difficult it will be to introduce the material into wood, particularly when the wood has pores of small dimensions which is the case with woods such as ash, persimmon, walnut, maple, birch, oak, hickory, ebony and cocobolo. There is less objection to the use of a resinous material having molecules of a relatively large size when the pores of the wood are also of relatively large dimensions as is the case with woods such as spruce, pine, cedar, cypress, balsa, and basswood.

The material that we have found to be well suited for carrying out impregnating operations on woods such as ash, largely used in baseball bats, or persimmon, generally used in golf club heads, or maple or birch, commonly used for the backs of various kinds of brushes, is preferably made as follows: 1000 parts by weight of commercially pure phenol are mixed with 875 parts by weight of 40% formaldehyde to which 21 parts by weight of a suitable catalyst, such as sodium carbonate, are added, and the resulting mixture is then heated under reflux conditions for a period of about three hours. At the end of that period approximately 13 parts by weight of a suitable neutralizing agent, such as lactic acid, are added to the mixture and the whole is then dehydrated until the water content is approximately 25% of the whole.

A resinous material suitable for carrying out impregnating operations on woods of a more porous nature, such as pine, cedar or cypress, is preferably made as follows: 1000 parts by weight of commercially pure phenol are mixed with 1600 parts by weight of 40% formaldehyde to which 15 parts by weight of sodium hydroxide are added, and the resulting mixture is then heated under reflux conditions for a period of about four hours at which time approximately 34 parts by weight of lactic acid are added. The mixture thus produced is then dehydrated until the water content is approximately 20% of the whole.

Materials made as described are substantially water soluble. Upon being subjected to further heating they become insoluble.

In lieu of sodium carbonate or sodium hydroxide, some other suitable catalyst, such as potassium hydroxide may be used in an amount sufficient to produce the desired result.

Instead of lactic acid, another suitable acid such as hydrochloric acid or acetic acid may be employed as the neutralizing agent in sufficient quantity to produce the desired neutralizing effect.

To each of the aforesaid partially dehydrated resinous base mixtures freshly made, 1 part by weight of methyl alcohol is preferably added to each 10 parts by weight of the base mixture to produce the desired impregnating solution. In lieu of methyl alcohol a sufficient quantity of any other suitable agent adapted to retard, or prevent to any substantial extent, polymerization of the resinous material, such as ethyl alcohol, isopropyl alcohol or butyl alcohol, may be used when water in the amount mentioned above is also used in combination therewith. The agent or solvent employed for the purpose mentioned should be sufficiently volatile so that it will readily evaporate when the treated articles are placed in the curing chamber and in order that polymerization of the resinous material may then effectively proceed. The amount of methyl alcohol or other agent used as the solvent depends somewhat on the age of the base material, a greater proportion of solvent being desirable when the viscosity of the base material is increased by the ageing of the material.

The aforesaid impregnating solutions are most efficient when used at temperatures ranging from about 40° C. to about 60° C., depending upon the boiling points of the particular solvents used in the solutions. The degree of viscosity of the solution, as controlled by the temperature at which it is used and the amount of solvent employed, is to be determined by the operator in accordance with the condition of the wood or other material being treated, depending on whether or not it is desired to use a vacuum in the preliminary procedure, depending on whether or not pressure is to be used for forcing the solution into the pores, and depending on the depth and extent of impregnation desired. In any case where a vacuum is employed and where a reflux condenser is not used, the temperature should be kept low enough to prevent boiling of the solution, since the viscosity of the solution would increase rapidly and would be difficult to control practically if boiling were to take place without a reflux condenser.

In preparing wooden articles for impregnation, preferably the pores at the surface of the wood are first cleaned by the immersion of the articles in water hot enough to have a limited dissolving action on the binders of the wood and serving by an expansion action or otherwise to expel the dirt and dust from the pores. The water should not be hot enough to color or crack the wood, being preferably at a temperature ranging from about 60° C. to about 90° C. The articles may be left in the hot water from twenty seconds to about a minute according to the density of the grain of the wood, it being undesirable that any appreciable amount of water be drawn into the wood by capillary attraction or otherwise.

In lieu of cleaning and opening the pores of the wood by the use of hot water, more efficient agents may be desirable in some cases. The desired result can be accomplished by the use of other agents, such as a solution of sodium hydroxide, a solution of sulphurous acid, or a solution of calcium bisulphite, employed under the same working conditions as above set forth in connection with the use of water. If a solution of sodium hydroxide is employed, it should be subsequently neutralized, as by dipping the articles into a solution of sulphurous acid or otherwise.

If the wood is to be colored, the dye can be introduced to advantage with the water or other solution used for the washing, vacuum and pressure being employed if desired for carrying the dye deeply into the wood.

After the surface pores of the wood have been cleaned, the moisture is to be driven out preparatory to impregnation, this being accomplished preferably in an oven. The heat for this purpose should range from about 40° C. to about 85° C., the necessary drying being effected ordinarily in about three hours or less, depending on whether or not provision is made in the oven for keeping the humidity down by circulation of air therethrough or in any other suitable manner. After being dried as described, the articles are next

preferably subjected to the influence of a substantially complete vacuum within a heated chamber for a period of from five to ten minutes to remove the air and any moisture that may be in the pores. The vacuum is then partially relieved so as to have a pressure of about one-fifth of an atmosphere about the articles, whereupon the impregnating solution is admitted to the desired depth in the chamber about the articles, such impregnating solution being preferably at a temperature of about 50° C. After the impregnating solution is in position about the articles, the vacuum is entirely relieved, so as to have normal atmospheric pressure about the articles, which are ordinarily left in the impregnating solution for a period of approximately fifteen minutes for permitting the solution to penetrate the pores effectively.

Greater pressure than atmospheric may be applied if deeper penetration of the resin is desired, it having been found practicable to apply pressure of from 50 to 150 pounds per square inch, for a period of ten or fifteen minutes additional where deep penetration is desired. When such high pressures are employed, it is important that the pressure be reduced gradually when the period of its use is ended, since a sudden relief of the pressure within the wood would have a tendency to drive out the resin or even to break down the structure of the wood.

For evacuating and finally drying the pores of the articles and for carrying out the impregnation step of our improved process, we have provided an apparatus of special design, as shown by our drawing, which will now be described. This apparatus comprises a heavy, strong receptacle 10 made of steel or other comparatively cheap metal and comprising an inner shell 11 and an outer shell 12, having a steam coil 13 mounted about the sides of the inner shell. A second receptacle 14 is provided which in the construction illustrated is similar generally to the receptacle 10, comprising an inner shell 15 of approximately the same inside size as that of the shell 11, and an outer shell 16, having a steam coil 17 mounted about the sides of the inside shell. The lower ends of the coils 13 and 17 are connected by a line of piping 18 with a source of steam, the connection with each of the coils comprising a shut-off valve 19 and a heat-controlled drain trap 20 of any approved construction which is arranged for draining the condensate from the associated coil when the temperature at the trap falls substantially below 100° C. The upper ends of the coils open into the space between the two shells. Drain pipes 21 provided with shut-off valves 22 are connected with the outer shells, and drain pipes 23 provided with shut-off valves 24 are connected with the inner shells. An overflow pipe 25 is connected with the outer shells near their upper ends, through which any surplus of water or other suitable heating medium may escape from the space about the heating coils.

The receptacle 10 is provided with a cover plate 26 hinged thereon and adapted to be secured down in tight-closure position by means of swivel bolts 28 spaced about the periphery of the plate. At opposite sides, the cover plate 26 is provided with glass-covered peep or sight opening 27 through which the progress of the operations in the receptacle can be observed. The receptacle 10 is also provided with means for exhausting the air therefrom, together with means for providing a heavy pressure therein when desired. This means comprises a pipe 29 having a pressure gauge 30 connected therewith and having two branches 31 and 32 for connection with a pressure pump and a vacuum pump, respectively, each of said branches being provided with a shut-off valve 33 therein. A shut-off relief valve 34 is connected with the pipe 29.

Our apparatus further comprises containers 35 adapted to have an easy working fit within the receptacles 10 and 14 so as to serve as liners for said receptacles for keeping the impregnating solution out of contact with the metal of the receptacles. By the use of such containers 35, which are preferably formed of thin sheet metal, the handling of the articles for insertion into and withdrawal from the receptacles 10 and 14 and the manipulation of the containers for the necessary cleaning operations may be effected readily and easily. We have found that when phenol-formaldehyde resins are used for impregnating it is necessary from a practical standpoint to clean the containers thoroughly after each impregnating operation in order to prevent the formation of a coating or scale of the hardened resin on the parts coming into contact with the solution and in order to keep the parts in condition for convenient handling. If cleaning is delayed for a considerable time after an impregnating operation, or if a container is used for more than a single operation without an intermediate cleaning, it is almost impossible to remove the hardened resin from the surface, since it is practically impossible to prevent a start of the polymerization during or after the heat treatments included in the impregnation. In order to make such cleaning effective it is necessary from a practical standpoint to immerse the container in a heated solution of sodium hydroxide or other strong alkali whereby all of the ingredients of the impregnating solution are completely removed.

There is another marked advantage in the use of liners or light containers for receiving the impregnating solution, in that such impregnating solution is adapted to have a highly objectionable reaction with the ordinary cheaper metals such as it is desirable to use for the manufacture of the heavy receptacle 10 which must be of adequate strength to accommodate the high vacuum and heavy air pressure alternately employed therein. In order to prevent such reaction, particularly when the impregnating solution is heated, we have found it necessary to employ a special construction of container. We have found that satisfactory results are obtained by the use of containers made of nicked or Monel metal, with which there is no objectionable reaction under any of the conditions prevailing in the practice of our improved process. By the use of the liners, which in the arrangement shown are formed of comparatively thin sheet nickel, the amount of the nickel or other expensive metal necessary to be used is kept to a minimum.

As is clearly shown in the drawing, each of the containers 35 is provided with perforated ears 36 at its upper end by which the container and its load are capable of being handled readily by the use of a hoist and crane or other suitable mechanism not shown. The containers are light enough to be manipulated easily by hand when empty.

In the arrangement shown in the drawing, the impregnating solution is introduced into the container 35 in the receptacle 10 through an up-

right pipe 37 extending downwardly to the bottom wall of the container, such pipe being supported by a grill 38 of any approved type resting on the bottom wall of the container, the lower end of the pipe having cut-out portions so that it is effectively open at all times. The pipe and grill serve as the supporting stand for the articles to be treated in said receptacle 10, said pipe and grill being also formed of nickel or other suitable material. When the supporting stand comprising the pipe 37 and grill 38 are in position in the receptacle 10, the upper end of the pipe 37 stands normally directly beneath the lower end of a line of piping 39 extending through and supported by the cover plate 26, a funnel 40 being loosely mounted in the upper end of the pipe 37 for preventing any splashing of fluid passing downwardly from the pipe 39 to the pipe 37. A shut-off valve 41 of any approved type is interposed in the piping 29, and a pet cock 42 of any approved type opens into the piping above the valve 41. A flexible hose 43 is provided, connected with the upper end of the pipe 39 at one end and provided with a readily operable coupling device 44 at its opposite end adapted to be connected readily with the upper end of the pipe 37 of a similar supporting stand located in the receptacle 14. The pipe 39 and its fittings, and the funnel 40, are also formed of nickel or other suitable material so as to prevent reaction with the impregnating solution and with the cleaning solution.

In carrying out our improved process as above set forth in connection with the apparatus just described, an adequate supply of impregnating solution is placed in one of the liners 35 and brought to the proper temperature within the receptacle 14, such liner 35 being empty except for the presence of the solution and the supporting stand comprising the pipe 37 and grill 38. At the same time, the receptacle 10 is brought to the desired working temperature by means of the coil 13. A thoroughly cleaned container or liner 35 is then provided with a cleaned supporting stand, and a supply of articles to be impregnated is placed in position on the supporting stand within such liner, the liner and its load being then lowered into position within the receptacle 10. The cover plate 26 is then secured in closed position, the flexible hose 43 being connected with the pipe 37 of the supporting stand in the receptacle 14, and the several valves 41, 42, 33 and 34 being all closed. As shown in the drawing the receptacle 14 is open to the atmosphere. The valve 33 in the branch pipe 32 is then opened and a substantially complete vacuum is produced within the receptacle 10 and maintained for a few minutes for completing the drying of the wooden articles and exhausting the pores thereof. The valve 34 is then opened momentarily to a slight extent for reducing the strength of the vacuum in the receptacle 10 so as to have an absolute pressure therein of approximately three pounds to the square inch, after which the valve 41 is opened under the continued control of the operator for causing the desired amount of impregnating solution to flow through the conduit comprising the pipe 37 of the receptacle 14, hose 43, and pipe 39, into the container 35 in the receptacle 10 through its pipe 37 about the articles being treated in said container. After the desired amount of solution has been drawn into position about the articles being treated, the valve 33 in the branch pipe 32 is closed and the relief valve 34 is opened for establishing normal atmospheric pressure in the receptacle 10.

If very deep penetration of the resin into the wood is desired, the valves 34 and 41 are closed and the valve 33 in the branch pipe 31 is opened for the production of the desired air pressure within the receptacle,—say from 50 to 150 pounds per square inch.

After the major portion of the impregnation solution is transferred from the liner 35 in position in the receptacle 14, as above described, the hose 43 is detached from the pipe 37 of the supporting stand in said liner and that liner is then withdrawn from the receptacle 14 and the remaining portion of the impregnating solution is removed from the liner, after which said liner is thoroughly cleaned and provided with a fresh supply of articles for impregnation ready for the next succeeding impregnating operation.

As our invention is preferably practiced, after atmospheric pressure has been restored in the receptacle 10 the liner therein, together with its load of articles and impregnating solution, is transferred to the receptacle 14 and such liner is at this time preferably provided with an additional quantity of the impregnating solution. Thereupon a clean liner with a load of articles to be impregnated is lowered into the receptacle 10 and the above described process is repeated and the impregnating solution drawn from the liner in the receptacle 14 into the liner then within the receptacle 10, whereupon the liner in the receptacle 14 is removed and the impregnated articles removed therefrom. It will be appreciated that in the preferred practice of our invention a saving of the time required for the absorption of the impregnating solution is effected by transferring the liner 35 from the receptacle 10 immediately after the impregnating operation to the receptacle 14 and then recharging the receptacle 10 with another line loaded with articles and the transfer of the impregnating solution from one to the other of the said liners by atmospheric pressure due to the production of a vacuum in the receptacle 10.

By the use of our improved, simplified and inexpensive apparatus as shown in the drawing, in which two light containers or liners 35 are used alternatively in the impregnating receptacle 10, with the other of said liners in position in the other receptacle 14, in which both of said receptacles are provided with means for heating the impregnating solution in the liners which have a working fit in the receptacles interchangeably, in which the receptacle 10 is provided with means for creating a vacuum therein or for providing a heavy air pressure therein as may be desired, and in which the liners or containers 35 and all other parts coming into direct contact with the impregnating solution are made of nickel or other material inert with respect to the impregnating and cleaning solutions, we are enabled to carry out the aforesaid steps of our process economically and conveniently with a minimum of labor and are enabled to make the practice uniform and routine for obtaining universally satisfactory results.

After the removal of the articles from the impregnating solution, the surplus resin is removed from the surfaces of the wood by any suitable means, in order to have the desired smooth unbroken surface on the completed article. This removal of the resin may be effected by a wiping or scraping operation, by the use of centrifugal

force generated by a rapid rotation of the articles, by chemical action or in any other approved manner.

In removing the surplus resin by chemical action, the articles are first dipped into a liquid agent adapted to dissolve the surplus resin on their surfaces. Any suitable agent which is a solvent of the resinous material may be employed. We have had satisfactory results by the use of agents such as methyl alcohol and ethyl alcohol. The agent is more effective if kept at a temperature of a few degrees, say about 5°, below its boiling point. The articles are dipped up and down in an agent as aforesaid long enough to insure effective removal of the surplus resin, additional quantities of the agent being added from time to time to offset the action resulting from the additional amounts of resin that are being continually added in carrying out this step. The solvent adhering to the surfaces of the articles should be reduced to a negligible quantity. If the resin in the aforesaid solvent is not permitted to exceed about 30% by weight of the whole and the solvent is used at a temperature as stated, no further treatment will usually be required, as the small amount of solvent in such case adhering to the surfaces of the articles will readily evaporate. However, when the conditions are other than as stated, it is advisable to employ special means to remove the surplus solvent. In such case, it has been found that this can be readily done by again dipping the articles up and down in a tank of a suitable agent such as dipentene or commercial spirits of turpentine, preferably maintained at a temperature above the boiling point of the solvent, say at about 75° C. when methyl alcohol is the solvent employed.

The resin removed by centrifugal force, or by chemical action as just described, may be recovered or concentrated in any suitable manner and used again for the impregnating operation.

The removal of the surplus resin by chemical action and the recovery of the resin so removed is described more in detail and claimed in our copending application Serial No. 15,901, filed of even date herewith.

After the removal of the surplus resinous material from the surfaces of the articles, they are ready for the drying or curing operation, which is preferably carried out in a chamber or oven at normal atmospheric pressure and heated to a temperature of from 60° to 100° C., a temperature of about 75° C. having been found preferable in most cases. The articles should be left in the drying chamber long enough to polymerize or harden the resinous material, and generally it has been found that this requires from 50 to 125 hours, depending to some extent at least on the acidity of the resinous material used in the impregnating operation, the temperature of the drying chamber, and the frequency the drying chamber is opened to put into it or take from it the articles.

We have found that by the practice of our improved process comprising the use of the resinous materials as above specified and comprising also an orderly procedure as above set forth with reasonable attention on the part of the operator, but not necessarily with laboratory precision, high-grade finished products can be readily produced without any frothing of the impregnating solution on the surfaces of the articles during the drying or curing operation and without any breaking down of the continuity of the sealing effect obtained by the polymerized resinous material, these results being obtained without the use of any pressure above normal atmospheric pressure during the drying or curing operation.

By the practice of our improved process, by which articles of wood and the like are effectively impregnated with a suitable resinous material and such material is, without the application of pressure above atmospheric thereon, cured and hardened in the pores of the articles without any frothing of the material during the curing operation, we have greatly simplified the operation of producing the impregnated and cured articles and have substantially reduced the cost of such operation, as well as improving substantially the quality of the articles so treated.

Our process has been found to be well adapted for the impregnation of many different kinds of articles of wood. When articles such as baseball bats are treated, they are placed on end within the liners 35 with their butt ends resting on the grills 38 and the impregnating solution is run into the liners to a depth of from 15 to 18 inches, it generally being unnecessary or undesirable to impregnate the bats throughout their entire length. When relatively small articles such as golf club heads, backs for brushes, etc., are to be treated, they are placed in wire baskets and the baskets are lowered into the liners and sufficient impregnating solution is used to cover the articles.

We are unable to state definitely at this time just what action takes place in the wood by virtue of which the resinous material is prevented from exuding during the drying and curing operation. The best explanation which we can offer with respect to the prevention of frothing during the practice of that step of our process is that the solvent employed to retard, or prevent to any substantial extent, polymerization of the resinous material during the impregnating operation is effectively removed from the presence of the material by a dialytic action while the resinous material proper is retained in the pores of the wood. It is known that in order to cure the resinous material contained in the pores of the treated wood, the solvent must be separated or removed from the immediate presence of the material. We have found that this may be effected by subjecting the impregnated articles to a temperature somewhat above the boiling point of the solvent and allowing the solvent to boil out. Ordinarily when this takes place without the application of a high pressure, the vapors rising from the interior parts of the wood tend to carry the resinous material, which is near the surface, out of the pores and on to the surface. It is known that the resinous material is capable of readily penetrating the pores of the wood. However, the relatively finer fibrous structure of the wood surrounding the pores prevents any ready penetration by the resinous material. The walls of the pores are composed of small membrane-like structures which have the property of retaining colloidal solutions. Since the resinous particles carried into the pores of the wood by the impregnating process approach the colloidal order of magnitude, we believe that they are retained or held back in the pores while the agent, which is simultaneously present and has theretofore been used as a solvent to prevent polymerization, readily passes through the membranous structure and is dissipated through the finer fibrous structure of the wood.

We believe that the dialytic action just described is favored by certain conditions, namely,

that the molecular weight of the solvent should be as low as possible and that the quantity of solvent used should be kept at a minimum as compared with the resinous material. Water, which has a low molecular weight, would seem to be one of the best vehicles for carrying the resinous material into the pores of the wood, and we prefer to use, in conjunction with water which does not interfere with polymerization, only enough of a suitable agent to prevent, or retard to any substantial extent, polymerization of the resinous material while the impregnating process is being carried out. We prefer to use methyl alcohol as the solvent because its molecular weight is lower than that of any of the other alcohols that have been found to be suitable. Generally, the efficiency of the solvent decreases as the size of its molecules increases.

Our theory is based in part at least upon the fact that we have found that, when the resinous material is carried into the pores of the wood by the use of vehicles of relatively high molecular weight, it is impossible, without the application of pressure upon the articles substantially above atmospheric, to effect a hardening of the resinous material in the pores of the wood without frothing. When a vehicle comprising water and a suitable solvent, such as methyl alcohol, is employed, the hardening of the resinous material in the pores of the wood can be effected readily upon a commercial basis without the application of pressure above atmospheric and without any sign of frothing. It is clear accordingly that the conditions by virtue of which the resinous material is retained in the pores of the wood when carried thereinto by means of such a vehicle is comparatively positive and stable since our process has been found to be effective and reliable.

The relative quantities of phenol, formaldehyde, alkaline catalyst, acid neutralizing agent, water and solvent are the best known to us at this time for the purposes set forth but we are aware that the percentages can be varied to some extent without substantial detriment. Similarly, the details of the procedure of carrying out the various steps of our process can be varied without departing from the spirit of our invention as defined by the appended claims.

We claim:—

1. The herein described process of impregnating articles of wood and the like with a resinous compound which comprises subjecting the articles to heat and a vacuum for reducing to a negligible amount the moisture and air in the pores of the articles at least adjacent their surfaces, introducing into the pores of the articles a resinous material of the phenol-formaldehyde type having a water content of about 20% thereof at least and to which an alcohol of the lower monohydric type is added in the amount of about one part to about ten parts of said resinous material, and then placing the articles so treated in a heated chamber under substantially normal atmospheric pressure for removing the water and alcohol from the immediate presence of the resinous material and for curing the resinous material in the pores of the articles.

2. The herein described process of impregnating articles of wood and the like with a resinous compound which comprises subjecting the articles to heat and a vacuum for reducing to a negligible amount the moisture and air in the pores of the articles at least adjacent their surfaces, introducing into the pores of the articles a resinous material of the phenol-formaldehyde type having a water content of about 20% thereof at least and to which methyl alcohol is added in the amount of about one part to about ten parts of said resinous material, and then placing the articles so treated in a heated chamber under substantially normal atmospheric pressure for removing the water and alcohol from the immediate presence of the resinous material and for curing the resinous material in the pores of the articles.

3. The herein described process of impregnating articles of wood and the like with a resinous compound which comprises bringing the articles into contact with a heated fluid agent adapted to have a dissolving action on matter contained in the pores of the articles at least adjacent their surfaces and to open said pores, subjecting the articles to heat and a vacuum for reducing to a negligible amount the moisture and air in the pores of the articles, introducing into the pores of the articles a resinous material of the phenol-formaldehyde type having a water content of about 20% thereof at least and to which an alcohol of the lower monohydric type is added in the amount of about one part to about ten parts of said resinous material, and then placing the articles so treated in a heated chamber under substantially normal atmospheric pressure for removing the water and alcohol from the immediate presence of the resinous material and for curing the resinous material in the pores of the articles.

4. The herein described process of impregnating articles of wood and the like with a resinous compound which comprises subjecting the articles to heat and a vacuum for reducing to a negligible amount the moisture and air in the pores of the articles at least adjacent their surfaces, introducing into the pores of the articles a resinous material of the phenol-formaldehyde type having a water content of about 20% thereof at least and to which an alcohol of the lower monohydric type is added in the amount of about one part to about ten parts of said resinous material, removing the surplus resinous material adhering to the surfaces of the articles by bringing them into contact with a liquid agent which is a solvent of the resinous material and at a temperature a few degrees below its boiling point, removing the surplus solvent from the surfaces of the articles, and then placing the articles so treated in a heated chamber under substantially normal atmospheric pressure for removing the water and alcohol from the immediate presence of the resinous material and for curing the resinous material in the pores of the articles.

5. The herein described process of impregnating articles of wood and the like with a resinous compound which comprises bringing the articles into contact with a heated fluid agent adapted to have a dissolving action on matter contained in the pores of the articles at least adjacent their surfaces and to open said pores, subjecting the articles to heat and a vacuum for reducing to a negligible amount the moisture and air in the pores of the articles, introducing into the pores of the articles a resinous material of the phenol-formaldehyde type having a water content of about 20% thereof at least and to which an alcohol of the lower monohydric type is added in the amount of about one part to about ten parts of said resinous material, removing the surplus solution from the outside surfaces of said articles, and then placing the articles so treated in a heated chamber under substantially normal atmospheric pressure for removing the water and alcohol from

the immediate presence of the resinous material and for curing the resinous material in the pores of the articles.

6. The herein described process of impregnating articles of wood and the like with a resinous compound which comprises immersing the articles in a hot bath adapted to open the pores of the articles at least adjacent their surfaces, subjecting the articles to heat and a vacuum for reducing to a negligible amount the moisture and air in the pores of the articles, introducing into the pores of the articles a resinous material of the phenol-formaldehyde type having a water content of about 20% thereof at least and to which methyl alcohol is added in the amount of about one part to about ten parts of said resinous material, removing the surplus solution from the surfaces of said articles, and then placing the articles so treated in a heater chamber under substantially normal atmospheric pressure for removing the water and alcohol from the immediate presence of the resinous material and for curing the resinous material in the pores of the articles.

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