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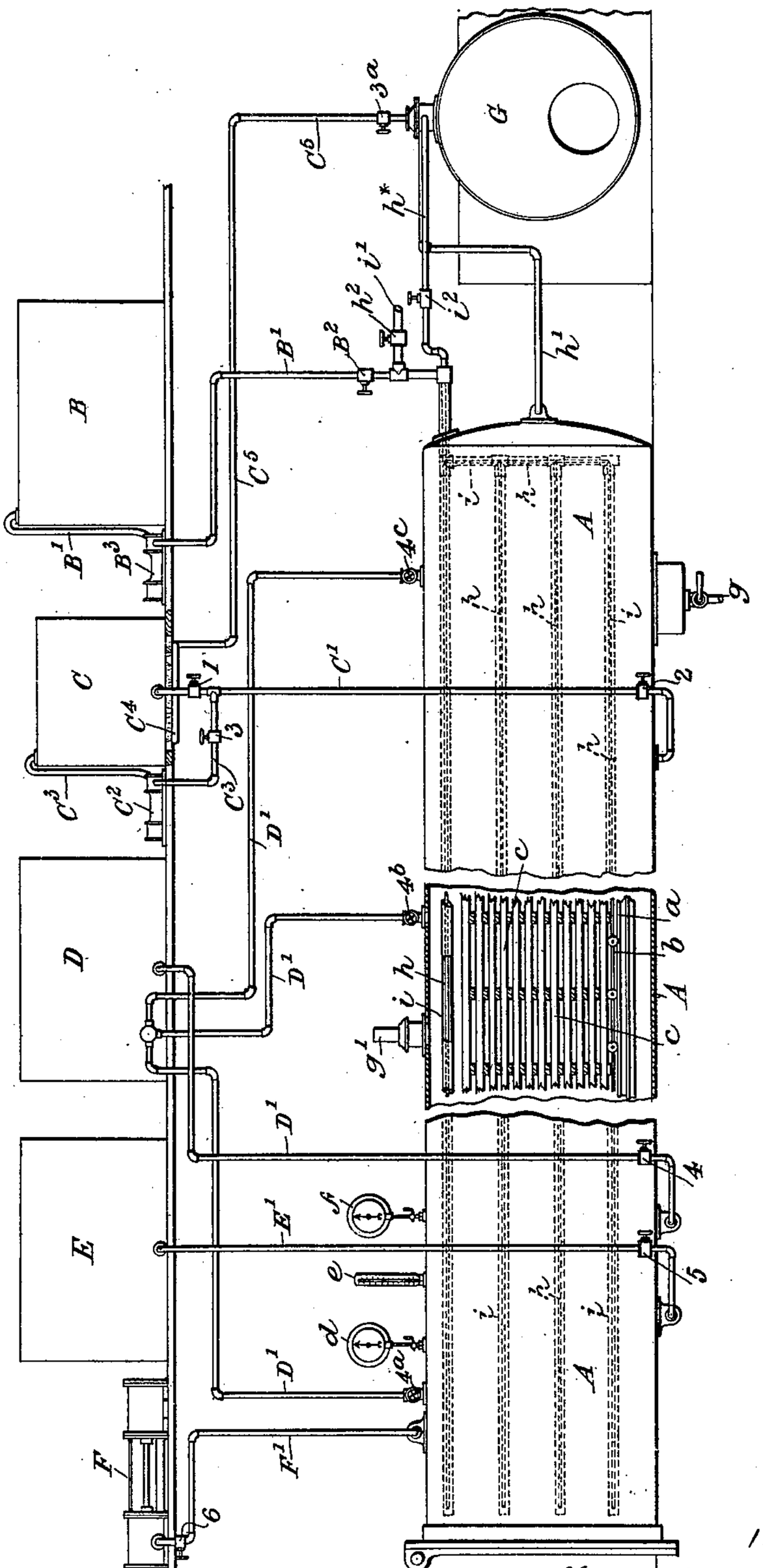
H. V. SIMPSON.

FIREPROOFING WOOD.

(Application filed June 13, 1898.)

(No Model.)



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HENRY VALENTINE SIMPSON, OF LONDON, ENGLAND.

FIREPROOFING WOOD.

SPECIFICATION forming part of Letters Patent No. 646,101, dated March 27, 1900.

Application filed June 13, 1898. Serial No. 683,355. (No specimens.)

To all whom it may concern:

Be it known that I, HENRY VALENTINE SIMPSON, of London, England, have invented certain new and useful Improvements in or Relating to the Treatment of Wood to Render it Non-Inflammable or to Preserve or Color It, of which the following is a specification.

This invention has for its chief object to effect improvements in the art of impregnating wood, more particularly for the purpose of rendering it non-inflammable or of preserving or coloring it.

Another object of the invention is to treat impregnated wood so that the same shall be waterproof or water-resisting and also corrosion-resisting.

According to the most successful recent methods employed for the purpose of impregnating wood, the wood is placed under a vacuum in order to as far as possible exhaust the air and moisture contained in its pores, and while in that condition there is presented to it a solution containing the desired ingredients. The pores of the wood being empty, suck up the solution, this being generally enforced by pressure, and then upon evaporation of the water, naturally or artificially, the said ingredients are left in the wood. The success of the operation depends on the degree of exhaustion of the air and moisture and also on the natural character of the wood. In the case of some woods—such, for example, as Weymouth pine and ash—impregnation has been effected to the depth of over two inches, while in the case of such woods as spruce, teak, pitch-pine, &c., the extent of the impregnation is found to be of a more variable character.

Now one object of my invention is to treat wood of all classes so that thorough impregnation of the same can be effected.

My invention comprises a preliminary process and a main impregnation process, respectively. It is not essential, though I consider it very important, except in the case of comparatively-thin pieces of wood or of easily-impregnated wood, to submit the wood to my preliminary treatment before the impregnation process—that is to say, the latter process can be followed without any preliminary treatment. The preliminary process will be employed when it is necessary to deal with woods of more than a certain thickness or density or with oily or resinous woods. Its object is to open up the pores of the wood and to dissolve out a certain part of its fermentable and soluble constituents. Now the resin in resinous woods, the oil in oily woods, and the closeness or blocking of the pores in various other woods prevent a proper impregnation. By the preliminary process the pores of the wood are opened up and cleared of oil, resin, and other matters which resist the action of the impregnating solutions.

Before proceeding to describe the process and to facilitate an understanding thereof I will briefly describe one form of apparatus or plant which is applicable for practicing the process and which is shown in the accompanying drawing, the single view of which is an elevation, partly in section, of such an apparatus.

A is a receiver for the wood. *a* are rails laid along the bottom thereof and upon which trucks *b* run, said trucks serving to carry the timber *c* to be treated. The receiver is fitted with a pressure-gage *d*, thermometer *e*, vacuum-gage *f*, blow-off cock *g*, and safety-valve *g'*. Along the whole length of the receiver runs a series of perforated pipes *h* and *i*, arranged concentrically to each other, the inner pipe *h* being for steam and the outer, *i*, for water. A pipe *h'* also serves to admit steam from the steam-boiler G to the receiver. The pipe *h* is connected to the steam-boiler G by a branch $h^{\times}$, and the branch *i'*, which supplies the water-pipes *i*, leads to any suitable source of supply. The water and steam supply to the pipes *h* and *i* may be controlled independently by means of the cocks h^2 and i^2, respectively, and it will be readily understood that by this means either steam alone or water alone may be run in onto the wood, or when both are turned on mingled steam and water reduced to spray thereby may be projected upon the wood.

B is a tank for containing the saponifying medium—say a solution of caustic soda or potash. It is connected to the water-supply branch *i'* by a pipe B', in which is a cock B^2, and a pump B^3 is employed to draw the solution from the tank B and force it to join the water supplied through the branch *i'*, the wa-

ter and solution being thus delivered to the wood through the perforated pipes *i*. When it is not desired to subject the wood to the action of a saponifying medium, the pump is not operated and the cock B^2 is kept closed.

C is a tank for containing liquor ammonia or other volatile solvent and connected to the receiver by a pipe C′, fitted with cocks 1 and 2. The pipe C′ is in communication below the cock 1 with a pump C^2 by means of a pipe C^3, fitted with a cock 3. This pump is employed when it is desired to deliver the volatile solvent—say ammonia—into the receiver in the state of gas.

C^4 is a heating-coil arranged beneath the tank C and connected to the steam-boiler by the pipe C^5. When steam is admitted to this coil by the cock 3^a, ammonia-gas is evolved from any suitable source of ammonia contained in the tank C, and the pump C^2 being put into operation, the valves 3 and 2 being open and cock 1 closed, the ammonia-gas is forced through the pipe C′ into the receiver. On the other hand, when the volatile solvent is to be admitted to the receiver in the liquid state the cocks 1 and 2 are open and cock 3 closed.

D is a tank for containing the impregnating solution. It is connected to the receiver by a series of pipes D′, controlled by cocks 4 4^a 4^b 4^c, so as to admit the solution to the receiver at several places at once for the purpose of covering the wood as quickly as possible.

E is a tank for the hardening solution, said tank being connected to the receiver by a pipe E′, controlled by a cock 5.

F is an ordinary air-pump connected to the receiver by a pipe F′, fitted with a cock 6 to open and close communication with the receiver. This pump serves, as will be readily understood, for creating a vacuum in the receiver, and by simply reversing it pressure may be produced in the receiver when desired—as, for instance, to enforce the action of any particular liquid.

I will now proceed to describe the process in detail, it being understood that the apparatus above described may be used in practicing the process, but as the process may also be employed with other apparatus I will describe it without reference to this or any special apparatus.

Preliminary process.—According to the preliminary process, after submitting the wood to the action of steam to open up its pores and free them of air and some of the more soluble constituents I cause the wood to absorb a solvent or medium whereby the object of the preliminary process as above explained is effected. The solvent or medium to be employed will naturally vary with the nature of the wood under treatment, but for general purposes I employ water, which may, if desired, be in the form of vapor or fine spray. For oily woods, such as teak, I may employ water rendered alkaline with soda or potash, borax, phosphate of soda, or the like, so as to cause a partial saponification of the oil, which will be more or less dissolved out, leaving the pores more open. In the case of resinous woods I may use, if necessary, a solvent of resin, such as methylated spirit, which I may employ in the state of vapor if desirable.

I will describe the preliminary process in the form most adapted for general application.

The wood to be treated is placed in an air-tight receiver capable of withstanding considerable pressure and connected with any suitable boiler capable of supplying steam-pressure and with an air-pump capable under favorable conditions of maintaining a vacuum in the receiver of about twenty-eight barometric inches. The receiver is then hermetically closed and steam is turned on from the boiler, the temperature and duration of the subjection depending on the kind of wood and the nature of that particular kind. For pine wood, for example, the temperature would be 212° to 220° Fahrenheit. In order that the structural strength of the wood should not be impaired, the action of the steam should not be prolonged beyond a certain time. Oak, for example, if exposed too long to the action of steam at a certain temperature is very apt to warp and crack. Soft woods—such as deal, pine, ash, and the like—are apt to become discolored under the same conditions, while teak, mahogany, pitch-pine, and the like will stand more severe steaming without material deterioration. For pine wood of one inch thickness the duration of steaming would be about four hours. The action of the steam is to heat the wood throughout, while not vulcanizing it, and to penetrate the pores, getting rid of the air and volatile matter and some of the more soluble constituents, a great proportion of which are driven off with the steam and drawn out of the receiver with the steam and air in the next stage of the operation. When the action of the steam has been sufficiently prolonged, the steam is blown off and the receiver placed in communication with the air-pump, which is then operated until a vacuum of preferably not less than twenty-six inches is produced, or a partial vacuum can be produced by condensation, if preferred. When the pores of the wood have thus been as far as possible exhausted, I admit the solvent medium to the receiver—say cold water for woods containing little or no resin, so as to cover the wood, the vacuum being maintained as long as possible. The water thus penetrates the pores of the wood. I then apply pressure to enforce the action until the wood has taken up as much as possible. The moisture is then dried off or exhausted, or in certain cases instead of employing water, as just described, to effect the extraction I may employ water-vapor, preferably at a low temperature—*i. e.*, below the boiling-point.

In this case after steaming the wood and subjecting it to exhaust, as above described, I admit the low-temperature water-vapor to the receiver. The wood thus takes up a quantity of moisture, which settles in the pores and tends to still further dissolve out the soluble and fermentable constituents in addition to those dissolved out by the first steaming. I may then lower the temperature to cause a further condensation in the pores of the wood and may allow the condensed moisture to remain in the pores for a few hours to assist the dissolving action. I then reëstablish the vacuum, (and, if desired, heat the wood to assist the exhaustion,) which will have the effect of evaporating the moisture and a portion of the volatile constituents, leaving the wood more porous than before, or instead of water-vapor of low temperature I may employ atomized water as the solvent agent. In this case after the preparatory steaming to open up the pores and exhaust I subject the wood in the receiver to the action of jets or sprays of atomized water, and after it has been exposed to the spray for a sufficient length of time I exhaust the receiver (and, if desired, apply heat) to evaporate the moisture and a portion of the volatile constituents.

If water-spray be employed, as just described, it may very advantageously be atomized by steam-jets disposed concentrically with water-jets by means of the concentric pipes *h i* in the apparatus before described or in any other well-known manner. A spray of combined steam and water is thus directed on the wood in the receiver, the air-pump working meanwhile, if necessary, to hold a partial vacuum. The wood is then deprived of moisture and a portion of the volatile constituents, as before.

The preliminary treatment may in any case be repeated until the desired result is obtained.

It is preferable that the wood should be dried before submission to the main process, since it would otherwise be necessary to increase the strength of the fireproofing, preservative or other impregnating solutions. In the case of thorough saturation the wood should be removed from the receiver and dried in a kiln or the like or in the open air. This will be the case when non-atomized water has been employed as the extracting medium. If, however, steam below the boiling-point or water-spray has been employed as the extracting medium, the wood can be, for the purposes of the main process, sufficiently dried in the receiver by the exhaust, (with or without heating,) which is hereinbefore described as the last step of the preliminary treatment in such cases. This is an advantage when time is a matter of consideration.

Main process.—The wood, whether it has been submitted to the preliminary treatment hereinbefore described or not, is placed in the receiver and subjected to the action of steam to open up its pores. The temperature of the steam and the duration of the steaming will vary with the nature and description of the wood under treatment, as described with reference to the preliminary process as the first step thereof. I have discovered that the resistance to the evolution of the volatile and soluble constituents is partially due to their resistance to being dissolved by ordinary steam and partially to the somewhat acid nature of the wood, and if this resistance can be overcome a much deeper impregnation of the wood can be obtained. Part of this invention consists in a method of overcoming this resistance. For this purpose I proceed as follows: When the wood has been steamed to its proper point, a vacuum is formed by the pump. I then introduce a certain quantity of a volatile solvent, such as liquor ammonia, which under the action of the vacuum is immediately drawn in and turned into vapor. The pores of the wood being to a great extent empty, this ammonia-vapor is able to permeate the wood. The effect of the ammonia is, as I believe, partly to neutralize the acid nature of the wood and partly to soften and render more amenable the less soluble (in water) constituents of the wood. Allowing the gas a few minutes to effect this permeation, I then cause steam from the boiler to be led into the receiver. The steam and ammonia-vapor mingle, and the pressure of the steam drives the ammonia-gas, now diluted with the steam, far into the pores of the wood. I maintain this pressure for as long as it is necessary to effect the purpose. I use the steam in order to obtain the pressure; but I may of course obtain the pressure by the use of a pump and pump in the ammonia-gas at the required pressure. When the ammonia-gas is sufficiently driven into the pores of the wood, I shut the connection between the boiler and the receiver and allow the receiver to cool, the result being that a vacuum of about twenty-nine inches, if the work is properly performed, can be produced, caused by the partial condensation of steam and ammonia-gas, and thus the condensed gases around the wood and in its pores are able to act on the wood. I leave the wood in this state for a little time and allow the ammonia to act on the soluble constituents and on the wood and so clear the way for the required solution of the fireproofing or other ingredients. If the receiver is air-tight, a vacuum is well maintained at not under twenty-eight inches. Under certain conditions I may at this point run in the solution, which will be sucked up by the wood, or I may employ the air-pump to exhaust the steam and ammonia, combined with a certain proportion of the volatile matters, which may be held in suspension, and may maintain a vacuum by the pump until I consider the wood is ready for the solution. The ammonia drawn off can be condensed and recovered, if desired. I then cause the solution to be run in either hot or cold, according

to circumstances and the nature of the ingredients used. I may of course cause the ammonia and steam to enter together, and I may use superheated steam in order to lessen the amount of condensation, while still maintaining the pressure, and so not dilute the ammonia too much. These modifications must necessarily depend more or less on the nature and the quality of the wood to be treated. In lieu of ammonia I may use volatile substances, such as alcohol, formaldehyde, benzine, carbon bisulphide, or the like, or I may use any of these combined. The use of a volatile solvent, as above described, has the further advantage of assisting in the preservation of the wood when the solvent has preservative or antiseptic properties.

A characteristic feature of this part of the invention is the application of some substance that will act as a solvent and not lose its property when vaporized. This differs, essentially, from the use of a fireproof solution in the form of a vapor for the purpose of saturating the wood with the fireproofing solution in a vaporized form, as has been already proposed. When a solution the vehicle of the ingredients of which is water is vaporized, the water is thrown off in the form of steam, leaving, as a general rule, the ingredients behind, its main object—namely, impregnation of the wood with the desired ingredients—being thus to some extent defeated. The use of ammonia in the treatment above described is particularly advantageous when the ingredients used in the subsequent impregnating solution contain ammonia salts, because the ammonia liable to be lost is, as I believe, replaced by the ammonia in the wood and in the receiver. There are other advantages in the use of ammonia as proposed—namely, that it will assist the subsequent drying of the wood. It is in itself fire-resisting and if some gelatinous body be used in the impregnating solution will have the effect of hardening it. If formaldehyde be used, it has the effect of tending to render insoluble any gelatinous substance that may be employed in the impregnating solution, thus causing the wood to be water-resisting. I prefer, however, to employ carbon bisulphide, as in practice I have found that the best results are obtained by its use.

The steaming operation, with or without the volatile solvent, may be advantageously repeated until the required result is obtained. The wood is then placed under exhaust until it is ready for the fireproofing or other impregnating solution, which is run in, and pressure, preferably of about one hundred to two hundred pounds per square inch, is applied to enforce the impregnation. The solution should, preferably, be cold, so as to prevent as much as possible the formation of vapor which would be sucked up by the wood and so prevent perfect penetration of the solution. It is also desirable to denude the solution of air before entering the air-tight receptacle, for the same reason—namely, to prevent air entering the pores of the wood. The solution should be submitted to the wood, so as to cover it as quickly as possible in order to avoid the wood taking up the vapor formed, which naturally would not contain the ingredients. In the case where the after use of the wood renders it necessary to guard against absorption of moisture and the consequent corrosion of metals in contact with it, such as nails, I may incorporate with the fireproofing ingredients a certain amount of some substance, such as size, which will materially assist in the object aimed at. As it is important that the solution be presented to the wood in the receptacle as speedily as possible, I may cause the solution to be run into the receptacle in a number of places, so as to cover the wood in the shortest possible time. When the wood has taken up as much as possible of the impregnating solution, it is withdrawn and dried, the water or other carrier of the solution being driven off as vapor, leaving the fireproofing or other ingredients behind in the wood. Complete drying is important, as the least heart moisture will burst through under the influence of heat and crack the surface and on evaporation will often leave a fine crust or powder composed of the ingredients used. For this reason too-rapid drying is not desirable.

A further feature of my invention consists in subjecting the wood after impregnation with the fireproofing or other solution to the action of a hardening solution, such as a solution of a salt of zinc or a salt of alumina or the two in combination. The effect of this treatment is to harden the wood at its surface, and it has the further advantage of rendering the wood waterproof and assisting the fireproof qualities, and in the case when a zinc salt has been used rendering the wood corrosion-resisting. I thus produce wood which is fireproof, waterproof, and anticorrosive, a result which has never hitherto been attained.

For the purpose of producing a fireproof, waterproof, and anticorrosive wood I prefer to fireproof with a solution of phosphate of ammonia and sulphate of ammonia and then to waterproof and render anticorrosive by means of a solution of acetate of alumina and a salt of zinc. Phosphate of ammonia, which is an excellent fireproofer, cannot advantageously be used simultaneously with acetate of alumina or zinc salts because mutual decomposition is produced. I have found, however, that when phosphate of ammonia and acetate of alumina or a zinc salt are employed one after the other the decomposition that is produced is so slight as not to detract from the fireproofing, waterproofing, or anticorrosive qualities. I therefore first run in the solution of phosphate of ammonia and sulphate of ammonia upon the wood while this is under exhaust, and after it has penetrated sufficiently far I run off this solution and after

more or less drying, according to the depth of waterproofing required, I admit a solution of acetate of alumina and a salt of zinc. I am thus enabled to overcome the difficulty presented by the mutually-decomposing action of solutions of phosphate of ammonia and acetate of alumina or salts of zinc, or I may admit the acetate-of-alumina and salt-of-zinc solutions separately to the fireproofed wood.

In order to enable my invention to be thoroughly understood, I will proceed to describe as a typical example the complete process as employed in the case of a piece of resinous pitch pine of considerable thickness with the object of rendering it fire and water proof and anticorrosive.

Preliminary process.—After steaming the wood to open up its pores I run in or spray a four-per-cent. aqueous solution of a suitable resin solvent—say borax or phosphate of soda—onto the wood in the receiver after its pores have been exhausted, as above described. The wood is then dried or partially dried, and I proceed to the

Main process.—The wood is subjected in the receiver to alternate steam pressure and exhaust, and this may be repeated. The volatile solvent is then introduced into the receiver while the wood is still under exhaust. Steam is led in under pressure to assist penetration of the volatile solvent if this has not been pumped in under pressure. After a sufficient time the temperature is reduced to condense the volatile solvent and after a sufficient time the receiver is again exhausted to prepare the wood for fireproofing, and the fireproofing solution—say phosphate of ammonia and sulphate of ammonia—is run in onto the wood in the receiver. Pressure is then applied to enforce the action until the impregnation is effected. The fireproofing solution is then withdrawn and a solution of a salt of zinc is run in for hardening, anticorrosion, and waterproofing purposes, or of alum salts for waterproofing and hardening purposes only, or both solutions may be employed. The wood is then dried. There is thus produced a fireproofed wood impregnated to a greater or less depth with corrosion-resisting and non-hygroscopic salts.

What I claim, and desire to secure by Letters Patent, is—

1. The described process of treating wood, which consists in subjecting it first to a preliminary treatment including steaming and subjection to a solvent adapted to dissolve out soluble and fermentable constituents, second, to an impregnating treatment by steaming, vacuum, applying a volatile solvent, and immersing in an impregnating solution, and third, to a hardening treatment by immersing in a solution of metallic salts adapted to harden and waterproof the surface of the wood.

2. The described process of treating wood, which consists in subjecting it first to a preliminary treatment by steaming, and applying an aqueous solvent under pressure, then expelling the solvent, second, to an impregnating treatment by steaming, vacuum, applying a volatile solvent, with steam under pressure, then applying vacuum, then immersing in an impregnating solution, and third, to a hardening treatment by immersing in a solution of metallic salts adapted to harden and waterproof the surface of the wood.

3. The described process of treating wood, which consists in subjecting it first to a preliminary treatment by steaming it, then subjecting it to vacuum, then to the action of an aqueous solvent in conjunction with a saponifying medium, then applying pressure, and then removing and expelling the solvent by heat and vacuum; second, to an impregnating treatment by steaming it, then subjecting it to vacuum, then to the action of carbon bisulphide, then applying steam-pressure, and then cooling to condense the steam and carbon bisulphide and produce a vacuum, then immersing in an impregnating solution of fireproofing ingredients, as phosphate of ammonia and sulphate of ammonia, then applying pressure to enforce the impregnation, and then removing and drying the wood; and third, to a hardening treatment by immersing in a solution of salts of zinc and alumina, and finally drying the wood.

4. In a process of treating wood, the described impregnating treatment, consisting in steaming it, then subjecting it to vacuum, then to the action of a volatile solvent, then removing the volatile solvent, and then immersing the wood in the impregnating solution, and removing and drying the wood.

5. In a process of treating wood, the described impregnating treatment, consisting in steaming it, then subjecting it to vacuum, then to the action of a volatile solvent, then applying pressure, then removing the volatile solvent, and then immersing the wood in the impregnating solution, and removing and drying the wood.

6. In a process of treating wood, the described impregnating treatment, consisting in steaming it, then subjecting it to vacuum, then to the action of a volatile solvent, then applying steam under pressure, then cooling to condense the steam and solvent, and then immersing the wood in the impregnating solution, and removing and drying the wood.

7. In a process of treating wood, the described impregnating treatment, consisting in steaming it, then subjecting it to vacuum, then to the action of carbon bisulphide, then to steam under pressure, then cooling to condense the steam and carbon bisulphide, and then immersing the wood in the impregnating solution, and removing and drying the wood.

8. In a process of treating wood, the described impregnating treatment, consisting in steaming it, then subjecting it to vacuum, then to the action of a volatile solvent, then

again to a vacuum, and then immersing it in an impregnating solution of fireproofing ingredients, as phosphate of ammonia and sulphate of ammonia, and then removing and drying the wood.

9. In a process of treating wood, the described treatment for hardening the wood after immersion in an impregnating solution, which consists in immersing it in a solution of a salt of zinc and a salt of alumina, and then drying the wood.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

HENRY VALENTINE SIMPSON.

Witnesses:

GEORGE C. BACON,

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