No. 620,114. Patented Feb. 28, 1899.

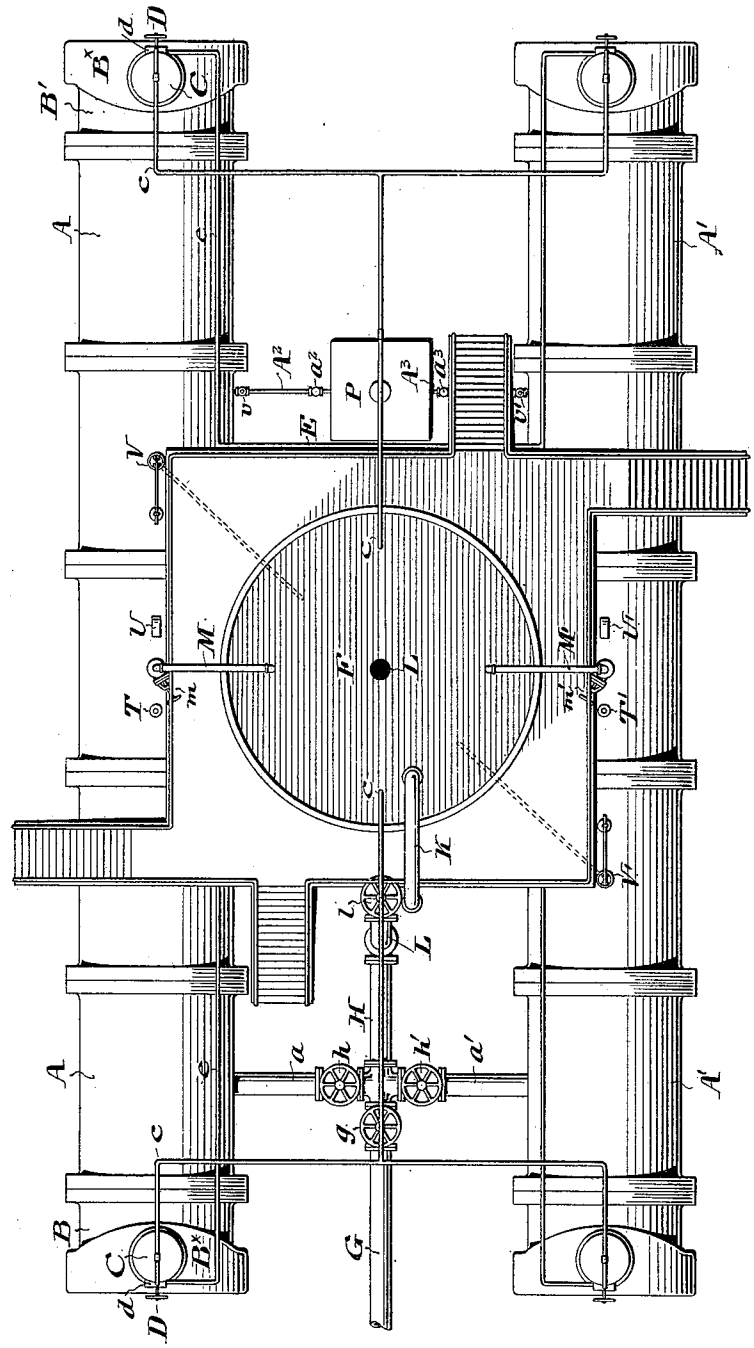
J. L. FERRELL.

METHOD OF AND APPARATUS FOR FIREPROOFING WOOD, &c.

(Application filed June 9, 1898.)

(No Model.) 4 Sheets—Sheet 1.

FIG. 1.



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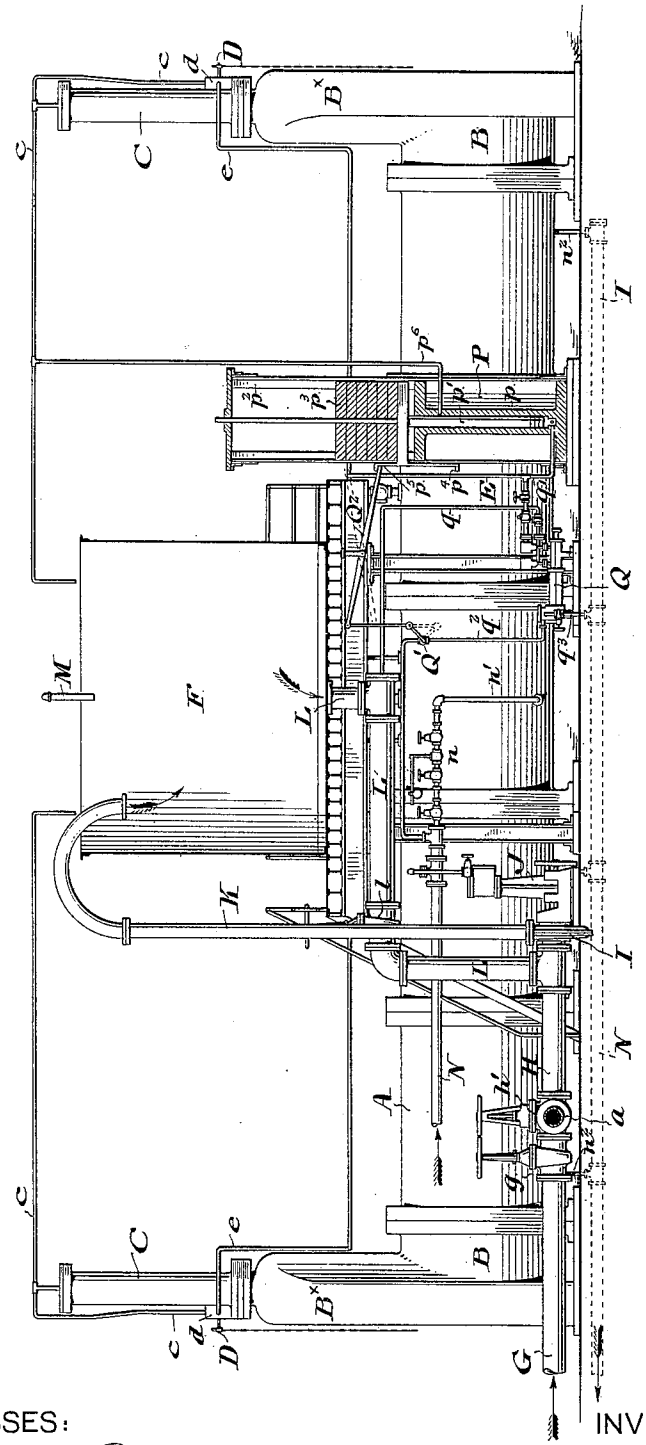
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(No Model.) 4 Sheets—Sheet 2.

FIG. 2.



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(No Model.) 4 Sheets—Sheet 3.

FIG. 3.

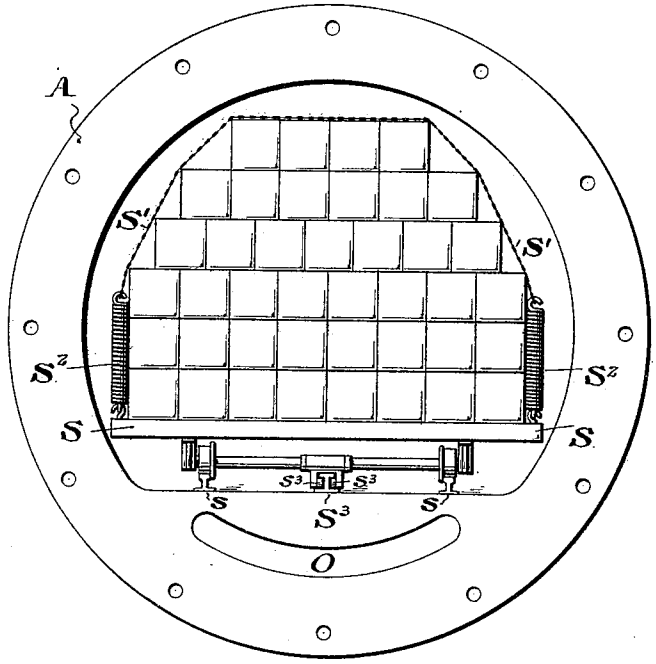
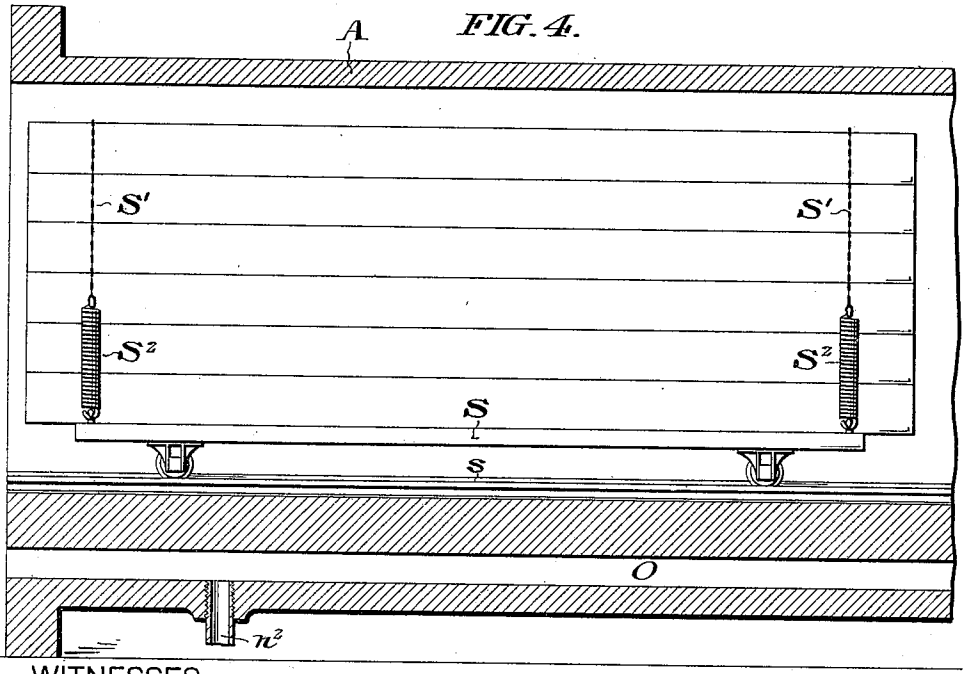


FIG. 4.



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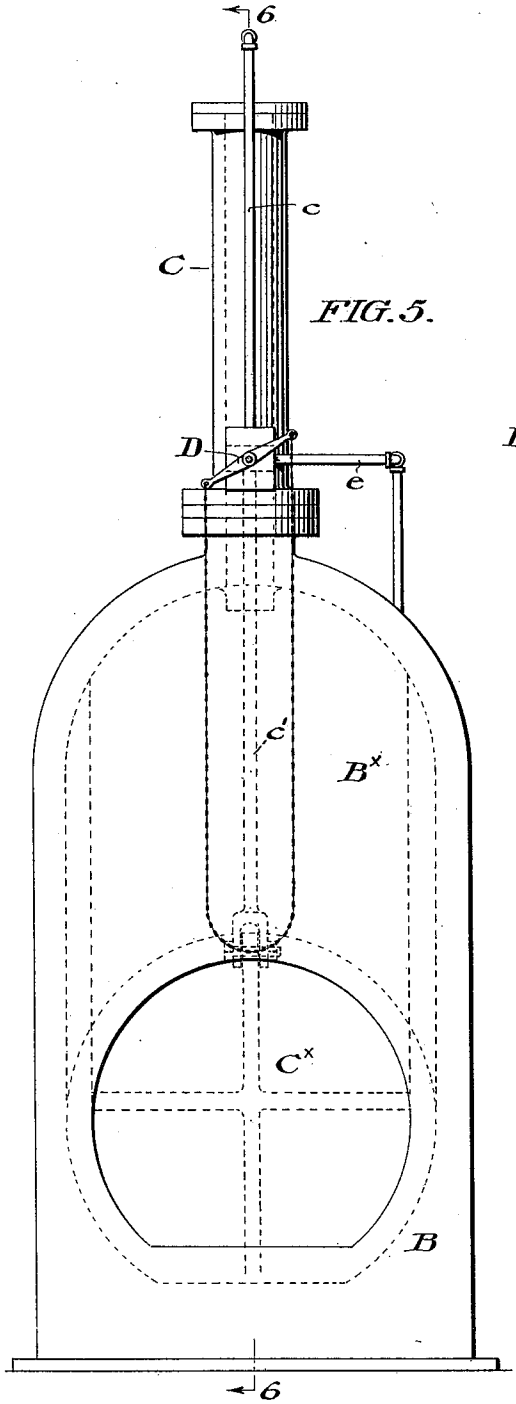


FIG. 5.

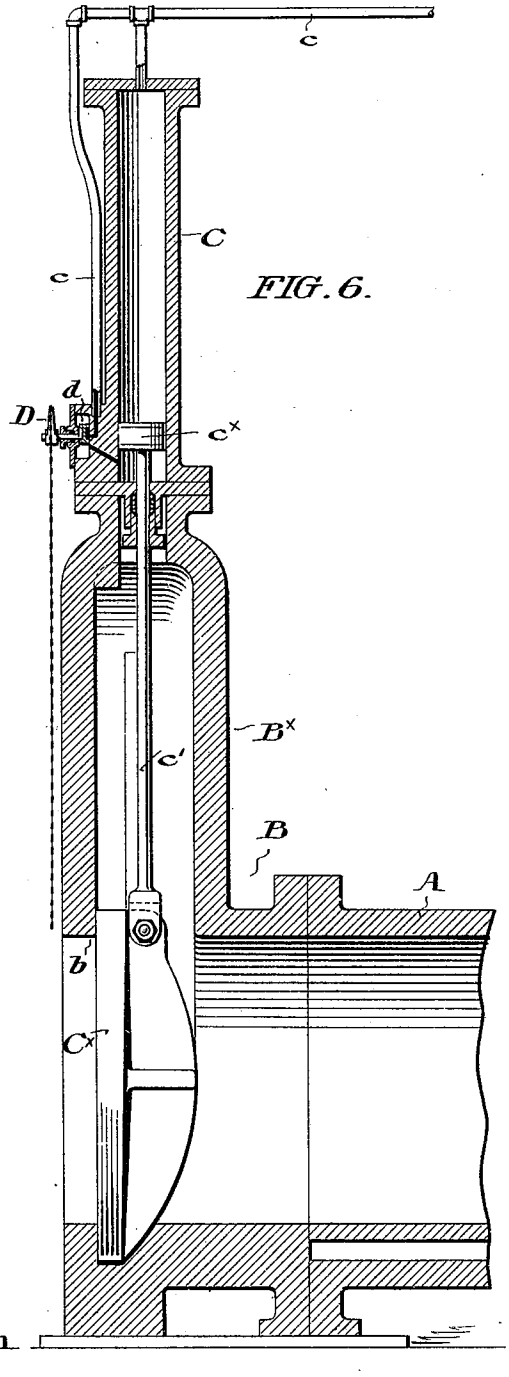


FIG. 6.

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UNITED STATES PATENT OFFICE.

JOSEPH L. FERRELL, OF PHILADELPHIA, PENNSYLVANIA.

METHOD OF AND APPARATUS FOR FIREPROOFING WOOD, &c.

SPECIFICATION forming part of Letters Patent No. 620,114, dated February 28, 1899.

Application filed June 9, 1898. Serial No. 682,979. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH L. FERRELL, of Philadelphia, in the State of Pennsylvania, have invented a certain new and useful Method of and Apparatus for Impregnating Cellular Substances, such as Wood, with Fireproofing Preservatives and other Reagents in Solution, of which the following is a specification.

The following is a specification of my said improvements, reference being had to the accompanying drawings, in which I have described a highly-organized type of apparatus adapted for economical working upon a commercial scale. To this end the apparatus is constructed in battery form, and comprises, in the instance shown, a pair of receptacles or cylinders, in which the material may be treated by alternating from one to the other, so as to provide for a measurable degree of continuity in the action of the apparatus as a whole. Various automatic appliances to minimize the personal attention required from the operatives are also indicated. It must be understood, however, that in showing this organized form of a working apparatus I do not mean to restrict my broader claims thereto, since the spirit of the invention could obviously be applied in a similar type.

The particular application of my method and apparatus which I at present contemplate is in connection with the fireproofing of wood, and I will therefore simplify the following description by adverting only to such a process, it being understood, however, that I do not, therefore, intend to limit my claims accordingly.

In the drawings, Figure 1 represents a top or plan view of the apparatus; Fig. 2, a longitudinal central vertical section. Fig. 3 is a transverse section, on an enlarged scale, through one of the cylinders or receptacles in which the wood is treated and showing the wood in position therein. Fig. 4 is a longitudinal vertical section through a portion of said cylinder. Fig. 5 is an end view of one of the cylinders, showing the method of construction for closing and opening the head thereof; and Fig. 6 is a vertical central section through the parts shown in Fig. 5 and on the line 6 6.

In various systems for impregnating wood with fireproofing material which have heretofore come under my notice I have found practical disadvantages, conspicuously in their effect upon the strength of the wood after it has been treated, there being a very noticeable tendency to crumble, shred, or split, owing to the friable character of the fiber after the treatment. In various experiments made by me upon this subject I have been led to the conclusion that these deleterious results are due mainly to the mechanical effects of the processes employed upon the wood fiber rather than to the chemical action of any particular reagents which are used to impregnate the wood. In some processes it has been customary to first subject the wood to what may be termed an "exhausting" process, with a view to removing the sap or other soluble ingredients as a preliminary step to the impregnation with the desired reagents. This has sometimes been accomplished by the admission of vapor under pressure to the chamber in which the wood was contained and the subsequent exhaustion of said chamber, with a view to allowing the contents of the wood-cells to be blown out, as it were. I believe that this method of treatment tends to result in the collapse or, at any rate, the deformity of many of the cells, thus not only impairing the strength of the material locally, but tending to destroy the general integrity of the capillary system of the wood. A further and perhaps more objectionable result in the same general direction—viz., of structural impairment—has been found by me to be due to the use of a sharply-pulsating supply of the fireproofing solution, the usual method being to pump the solution directly into the receptacle in which the wood is treated. I find that for commercial practice the wood must be subjected to a high degree of pressure in order to accomplish an effective and uniform impregnation within an economical limit of time. At such high pressures the rapid pulsation of a pump produces the effect of a water-hammer, which tends to disrupt the fibers of the wood and, moreover, is most severe upon the joints of the apparatus. My process, about to be described, avoids these disadvantageous results and yields a product which

will be found after thorough and comparatively rapid impregnation to possess substantially the strength of the original fiber.

I will now proceed to describe in detail the apparatus shown in the accompanying drawings when used in connection with a fireproofing process. The solution to be employed may be of any of the well-known types for the fireproofing of wood, the preferred and active ingredient, however, being a solution of ammonium phosphate, which may be used either alone or with other ingredients, as desired. As I do not, however, in the present application claim any particular solution and as the action of the process and apparatus is entirely independent of the character of the solution—*i. e.*, whether it be a fireproofing or merely preservative solution—I do not deem it necessary to enlarge upon this feature.

A A′ are the receptacles above referred to, in which the wood is completely inclosed during the saturating process, and which I shall hereinafter term the "impregnating-cylinders;" but as they are counterparts of one another I shall describe the various connections of the apparatus with particular reference to the cylinder A, which appears in side elevation in Fig. 2.

It is of course necessary that the interior of the impregnating-cylinder shall be readily accessible for the introduction of the wood and at the same time that there shall be no danger of leakage. To this end I have devised a new means of applying the cylinder-heads. The cylinder A terminates (preferably at each end) in short end sections B and B′, each of which comprises an internally overhanging circumferential flange *b*, and also a vertically-extending chamber $B^{\times}$. Upon the chamber $B^{\times}$ is mounted a hydraulic cylinder C, having a piston-head $c^{\times}$ and rod *c*′. At the lower end of the rod is pivotally attached the cylinder-head $C^{\times}$, which is adapted to seat itself closely against the inner face of the flange *b* and also to be withdrawn by a sliding movement into the chamber $B^{\times}$. The head is shifted by hydraulic pressure in the chamber C, transmitted to the valve-box *d* through the pipe *e*, branching from the pipe E, (shown in Fig. 2,) extending from the pressure-pump Q, hereinafter described.

D is a controlling-valve upon the cylinder C, provided with a depending hand-chain whereby, as shown in Figs. 5 and 6, fluid-pressure may be admitted from the valve-box *d* to the hydraulic cylinder C and subsequently exhausted therefrom through the outlet-pipe *e*.

I have described a hydraulic cylinder and piston as the preferred means for actuating the internally-seated sliding cylinder-head; but obviously any convenient mechanism capable of shifting the head may be substituted therefor.

The first step in my process is the introduction of the wood to the impregnating-cylinder and the closure of the latter, the piece or pieces of wood being completely inclosed thereby. The second step in the process is the charging of the closed cylinder with the solution with which the wood is to be impregnated. In the embodiment of my invention, which I have illustrated, said solution is made and primarily contained in the tank F, preferably located above the impregnating-cylinders A A′, so that it may flow to said cylinders by gravity. The pipe G (shown in Figs. 1 and 2) leads to a suitable water-supply. The valve *g* controls communication from the pipe G to the pipe H, and the latter leads to the pump I, (connected with and operated by the engine J,) and the discharge-pipe K of the pump I leads thence to the top of the tank F. The pipe L, extending from the pipe H to the bottom of the tank F, is used as an outlet for the contents of said tank F in the subsequent operation, but is provided with a stop-valve *l*, which is closed during the initial operation of filling the tank F with water from the pipe G. The pipes *a* *a*′, which extend from the pipe H to the cylinders A A′, respectively, are used in the subsequent operation to conduct the liquid from the pipes L and H to said cylinder. The valves *h* and *h*′, leading to said pipes *a* *a*′, are, however, closed during the initial operation aforesaid, and it is therefore obvious that with the valve *g* in open position the tank F may be filled with water from the pipe G by operation of the pump I. The desired amount of water being delivered to the tank F, the valve *g* is closed, and after a solution of the required character has been formed in the tank F the valve *l* is opened and the solution permitted to flow from the tank F through the pipes L and H and the pipes *a* *a*′, selectively, to the cylinder A or A′, containing the material to be treated. The pipes M M′ serve as air-vents for the respective cylinders A A′, being provided with valves *m* *m*′, respectively, which are open during the inflow of liquid from the tank F. The cylinder A having been thus charged with liquid from the tank F, the valves a^2 and *m* are thereupon closed.

N N′ are respectively steam supply and exhaust mains. The pipe N serves to supply the pumps of the apparatus with steam at the proper pressure and through the various valve connections, &c., (indicated at *n*) and the pipe *n*′. Steam is led from said main end to a steam-space O (shown in Figs. 3 and 4) at the bottom of the impregnating-cylinder. Said steam-space is drained by the pipes n^2 n^2, which at the opposite extremities of the impregnating-cylinder lead to the exhaust-main N′.

The aforesaid arrangement of steam-pipes, &c., serves as a convenient means for heating the contents of the impregnating-cylinders. While I do not desire to limit myself to the use of said means, it is desirable that the saturating liquid shall be heated to a temperature of, say, 160° Fahrenheit as a con-

venient and safe method of attaining expeditiously, but without violence or shock, the necessary degree of pressure.

P is what I shall term a "hydraulic accumulator," consisting, as shown in Fig. 2, of a vertically-disposed cylinder p and a plunger p', adapted to reciprocate in said cylinder. A housing p^3 extends above the top of said cylinder p, so that the plunger p' may be weighted, as indicated at p^3, to any desired pressure per unit of area of the plunger p'. For the purpose of treating wood as aforesaid said plunger p' is weighted to a pressure of, say, five hundred pounds per square inch and the cylinder p is filled with the saturating liquid at the desired pressure by means of the pump Q. The pipe q serves to convey liquid from the tank F to said pump, and the pipe q' conveys the liquid from the pump to the accumulator beneath said plunger p'. The pump Q is conveniently operated by steam supplied through the pipe q^2 from the main N, q^3 being the exhaust-pipe of said pump leading to the main N'.

q' is a throttle-valve in the steam-pipe q^2 leading to the pump, and serves to automatically control the operation of the latter through the lever Q^2, which is raised or lowered by the tappets p^4 p^5, which rise and fall with the plunger p'.

The relation of the parts just described is such that when the plunger is in the position shown in Fig. 2 steam is admitted to the pipe q^2 to operate the pump Q, and when said plunger is raised by the operation of said pump to the desired limit the tappet p^4 contacts with the lever Q^2 and through the latter shifts the valve Q' into the closed position. (Indicated by the dotted lines in Fig. 2.)

I prefer to provide the outlet-pipe p^6 at the top of the accumulator-cylinder, so that if the pump Q should for any reason continue to operate after the desired limit of upward movement of the plunger p' was reached the continued operation of the pump would simply serve to return the surplus contents of the accumulator-cylinder p through said pipe p^6 into the tank F.

The accumulator P is connected at the bottom with the impregnating-cylinders A A' by the respective pipes A^2 A^3, and said pipes are respectively provided with hand-actuated valves a^2 a^3, which are closed during the above-described steps of the process.

To render the action of the apparatus to a certain degree automatic, I find it convenient to employ check-valves v v' (opening toward the cylinders) in the pipes A^2 A^3, and when these are used the other valves a^2 a^3 may be left open during the main portion of the operation. When the liquid contained in the impregnating-cylinder has reached the desired pressure through the rise of temperature, where heat is employed for that purpose, communication is established between the liquid in the impregnating-cylinder and that in the accumulator, which latter should of course be under a corresponding pressure, so that although the wood under treatment rapidly absorbs a considerable portion of the saturating liquid the desired pressure and supply are maintained therein by the automatic action of the accumulator, the plunger p' sinking as the liquid flows from the accumulator into the impregnating-cylinder until the tappet p^5 shifts the lever Q^2, opens the throttle-valve Q', and causes the pump Q to operate, thus further supplying the accumulator with liquid at high pressure. When the check-valve is employed to control the communication between the accumulator and cylinder, it of course remains closed as long as the pressure in the cylinder exceeds that within the accumulator; but when the cylinder-pressure falls by absorption of the liquid the check-valve opens and admits more liquid to maintain the supply.

Although the pump Q may, as aforesaid, be brought into operation after communication has been established between the accumulator and the impregnating-cylinder, it is to be observed that said pump does not deliver the liquid directly into said cylinder, but into the accumulator. Thus the pulsations of the pump are wholly taken up by the movements of the plunger p' within the accumulator, and the water-hammer blows upon the contents of the apparatus are avoided. This step in my process, therefore, consists in the maintenance of a quiet and substantially uniform high pressure of the solution acting upon the wood during a sufficient length of time to effect the complete impregnation of the latter.

Although I have described a particular type of accumulator as a means by which a continous supply of the liquid to the impregnating-receptacle at a high and constant pressure may be maintained without shock, I do not desire to limit myself to said means. It is, however, essential to the preservation of the cellular structure of the wood that the means whereby the supply of liquid at high pressure is continued, as aforesaid, during this step of my process shall be operative without substantial shock, for the reasons hereinbefore set forth.

On the completion of the impregnation the valve a^2, leading from the accumulator to the impregnating-cylinder, is closed and the valve h, leading from said cylinder to the pipe H, and the valve m in the air-vent pipe M are opened, whereupon the pump I is set in operation, and the liquid contents of the cylinder A are drawn off through the pipes a and H and delivered into the tank F through the pipe K. After the surplus saturating liquid has been removed from the cylinder A one of the gates $C^\times$ of the latter is opened in the manner hereinbefore described, and the wood, which has been subjected to the process aforesaid, is withdrawn and subsequently dried.

As a matter of convenience I prefer to provide both ends of the impregnating-cylinder with the sliding heads, so that the material to be treated may be introduced from the lumber-supply at one end and withdrawn at the opposite end for direct delivery to the drying-kiln.

To facilitate the handling of the lumber, I prefer to provide the interior of the cylinders A A′ with tracks *s s* for trucks or cars S S, as shown in Figs. 3 and 4, upon which the lumber may be loaded exterior to the cylinders, and thus introduced therein. Much time is saved by the retention of the wood upon the trucks during the process. I find it convenient, therefore, to secure the material thereon by bands or chains S′, extending from side to side of the truck-frames, the expansion of the timber during the saturating process being, however, permitted by the spring-terminals S^2 of said bands. A rail S^3, having overhanging flanges, as shown, is secured along the bottom of the impregnating-cylinder and engages with underhanging rollers s^3 upon the truck S and serves as a convenient means to prevent the mass of lumber and the trucks from floating from the tracks *s s*.

To facilitate the manipulation of the apparatus in the successive steps of the process, various adjunctive devices may be employed. Thus I have indicated upon Fig. 1 thermometers T T′ and pressure-gages U U′ and of course safety-valves V V′, and devices of that nature may be inserted in the apparatus wherever convenience may dictate.

It will be observed that in the organization above described I initiate the pressure by heating the liquid in the impregnating-cylinders, that being obviously the most rapid and economical method of attaining the desired degree of pressure in the first instance. I do not, however, limit myself to this particular method of applying the initial pressure, it being only essential for the conduct of this step of my process that the desired degree of pressure shall be attained without substantial shock to the cellular tissue.

Having thus described my invention, I desire to note the following points by way of distinguishing it from former processes intended for the same general purpose.

By dispensing with any preliminary treatment of the wood in the direction of saturating it with vapor and subsequently withdrawing the liquid contents and by directly impregnating the wood with a liquid solution under a high pressure applied to the entire surface thereof, said pressure being attained gradually and attained and maintained without substantial shock, I avoid all injury to the structure of the wood, and thus preserve to the greatest possible extent the original strength, durability, and texture. As a convenient expression to indicate the absence of substantial or injurious shock, which characterizes my process, I designate the pressure as "quietly" attained and the supply as "quietly" maintained.

I am of course aware that it is not new, broadly speaking, to treat wood with a liquid solution in the absence of preliminary vapor treatment, and I do not broadly claim the same. The dispensing with the preliminary blowing out of the wood is only incidental to the main principle of my invention, which is, as before stated, the avoidance or minimizing of shock and undue strain upon the cellular tissue.

As compared with a mere soaking process, my invention presents the great advantage that I am enabled to use a high pressure attained and maintained, as before stated, without shock, and hence to greatly expedite the impregnation of the wood, and I use the term "high degree of pressure" to distinguish the relatively great pressure which I am thus enabled to attain rapidly but without pulsatory violence from any of the very low-pressure soaking processes, which, while in one sense avoiding disturbance of the fiber, are so slow and uncertain as to not only render the process commercially unavailable by reason of the great expenditure of time, but also yield an imperfect product not uniformly impregnated or, indeed, not impregnated at all in some of the more inaccessible parts. The distinctions from prior processes, though apparently small, as thus stated, are highly substantial in the results obtained, and I thus advert to them in order to avoid that confusion which might otherwise exist in view of the vague descriptions found in some of the earlier and now abandoned methods. I believe that I am the first to discover and apply the vital feature of directly treating the wood with liquid solution at a high pressure under conditions which obviate what I believe has been universally found to be the disastrous effects of such pressure.

The use of a very high pressure, preferably in the neighborhood of five hundred pounds to the square inch, is the vital and important factor in successfully and economically treating wood where the primary blowing out of the contents of the cells is dispensed with, and as the utilization of such a high degree of pressure in vessels of the capacity required for commercial working is a difficult problem I have addressed my efforts in the organization of the apparatus embodying my improvements to meeting the conditions necessarily incident to this method of treatment. The impregnating-cylinder must be of large diameter and the head must be readily removable. It has been found almost impracticable to make a tight joint at the heads in the apparatus heretofore employed, and obviously any leakage either there or at any other weak point in the structure is at once attended by great diminution of the pressure.

Where the cylinder-heads are exteriorly applied in an apparatus having a cylinder of, say, seventy-eight inches in diameter, I do not believe it to be possible practically to preserve an absolutely tight joint, except by the use of fastening devices so cumbersome and difficult to manipulate as to require an enormous amount of time and labor to apply and detach them. Hence the importance of the type of cylinder-head above set forth, which requires no fastening at all, but is so devised that the internal pressure at once acts as the medium to tighten the joints, and thus absolutely prevent leakage. Furthermore, as such a cylinder-head is necessarily massive and of great weight the use of the hydraulic shifting device will be found a valuable adjunct, since the source of pressure for the hydraulic cylinder is directly at hand and can be instantly made available. Moreover, the feature of maintaining the necessary supply of liquid under quiet pressure is not only of importance in connection with the treatment of the wood itself, but is in the highest degree conservative of the apparatus, since nothing is more likely to cause leakage at any points of weakness than the repeated blows of a water-hammer.

I claim—

1. The hereinbefore-described process of impregnating cellular substances which consists in completely inclosing said substances in a receptacle and directly submitting the entire surface of such substances to the action of an impregnating liquid; gradually heating the solution until a high degree of pressure is quietly attained within said receptacle; quietly maintaining a supply of liquid at such high degree of pressure until the desired degree of impregnation has been obtained; and finally withdrawing the substance and drying the same, substantially as described.

2. The combination of an impregnating-receptacle, having means for opening and closing the same, and capable of completely inclosing the substance to be treated, a reservoir of liquid communicating with said receptacle, a supplying device as a pump, and appliances such as an accumulator between the supplying device and receptacle for maintaining a continuous supply of liquid to the impregnating-receptacle without shock to the contents of the receptacle; substantially as described.

3. The combination, of an impregnating-receptacle having means for opening and closing the same; a heating apparatus for said receptacle; a reservoir of liquid communicating with said receptacle; a hydraulic accumulator also communicating with said reservoir and with said receptacle; and a supplying device, such as a pump, intermediate between said reservoir and said accumulator, whereby a supply of liquid to the receptacle may be maintained through said accumulator under a definite pressure and without substantial shock to the contents of the receptacle, substantially as described.

4. The combination, of an impregnating-receptacle having means for opening and closing the same; a heating apparatus for said receptacle; a reservoir of liquid communicating with said receptacle; a hydraulic accumulator also communicating with said reservoir and with said receptacle; a supplying device, intermediate between said reservoir and said accumulator, whereby a supply of liquid to the receptacle may be quietly maintained through an accumulator under a definite pressure; a steam-supply for said pump; controlling mechanism for said supply; and a tripping device, substantially as set forth, operatively engaging with the moving member of the hydraulic accumulator, whereby upon the rise or fall of said moving member the supply of steam to the actuating device of the pump may be automatically closed or opened.

5. The combination, with the impregnating-receptacle, of an externally-projecting chamber arranged at the end thereof; a circumferential inwardly-facing seat arranged around the end of said receptacle; a sliding head adapted to close against said seat and to be withdrawn into said chamber; and means substantially as set forth connected with said head, whereby it may be withdrawn into said chamber, or permitted to move into position upon said seat, substantially as described.

6. The combination, with a pair of impregnating-receptacles and means for closing the same, of a reservoir arranged above the level thereof; supply-pipes leading from the bottom of said reservoir into said receptacle; valves controlling said supply-pipes; heating apparatus for said receptacles; a hydraulic accumulator communicating with said receptacle; valves for controlling said last-mentioned communication, including a check-valve interposed between said accumulator and said receptacles; a supply-pump having its intake in communication with said reservoir and its discharge in communication with said accumulator; a discharge-pump having its intake in communication with said receptacles and its discharge in communication with said reservoir; and actuating mechanism for said pumps, substantially as described.

7. The combination of an impregnating-receptacle, having means for opening and closing the same; a heating apparatus for said receptacle; a reservoir communicating with said receptacle; a hydraulic accumulator also communicating with said reservoir and with said receptacle; a check-valve interposed between said receptacle and said accumulator; and a supply device intermediate between said reservoir and said accumulator, whereby a supply of liquid to the receptacle may be automatically and quietly maintained

through said accumulator, in accordance with any diminution of pressure within the receptacle, substantially as described.

8. The combination with an impregnating-receptacle, of a track arranged upon the bottom thereof comprising a rail with overhanging flanges; a truck adapted to run upon said track and provided with underhanging rollers adapted to engage with said overhanging flanges; and spring-bands connected with said car and adapted to embrace and secure the contents thereof, substantially as described.

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