Sept. 3, 1935. S. P. MILLER 2,012,970

SATURATION OF ABSORBENT CONDUITS

Filed July 26, 1932 2 Sheets-Sheet 1

Fig. 1.

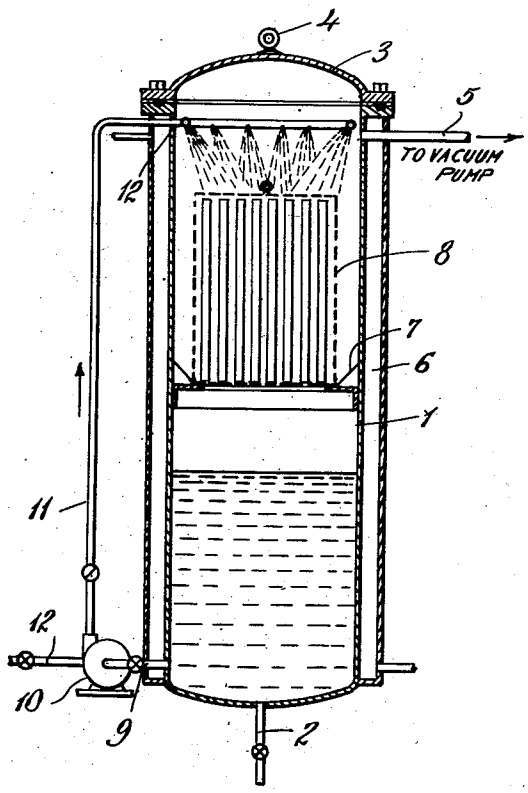


Fig. 2.

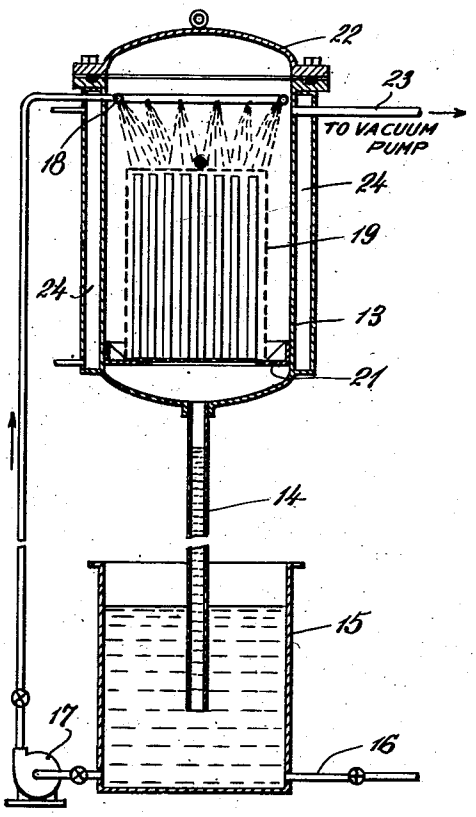
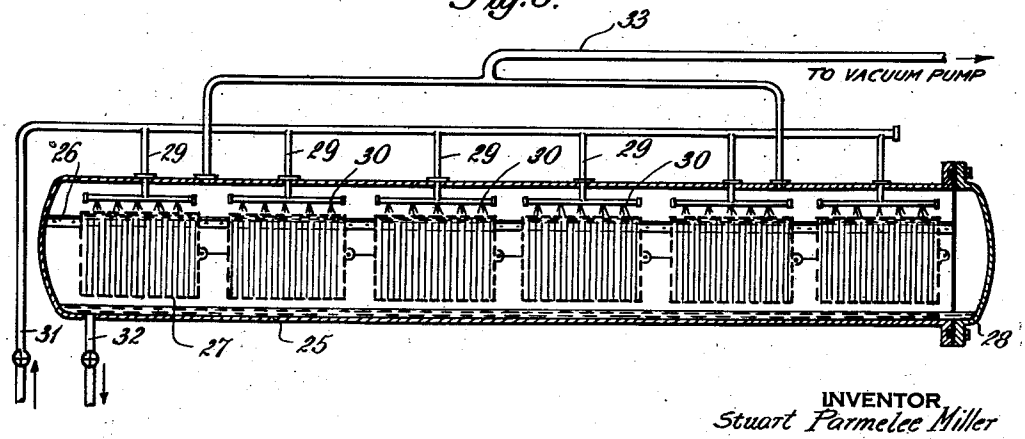


Fig. 3.



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Fig. 4,

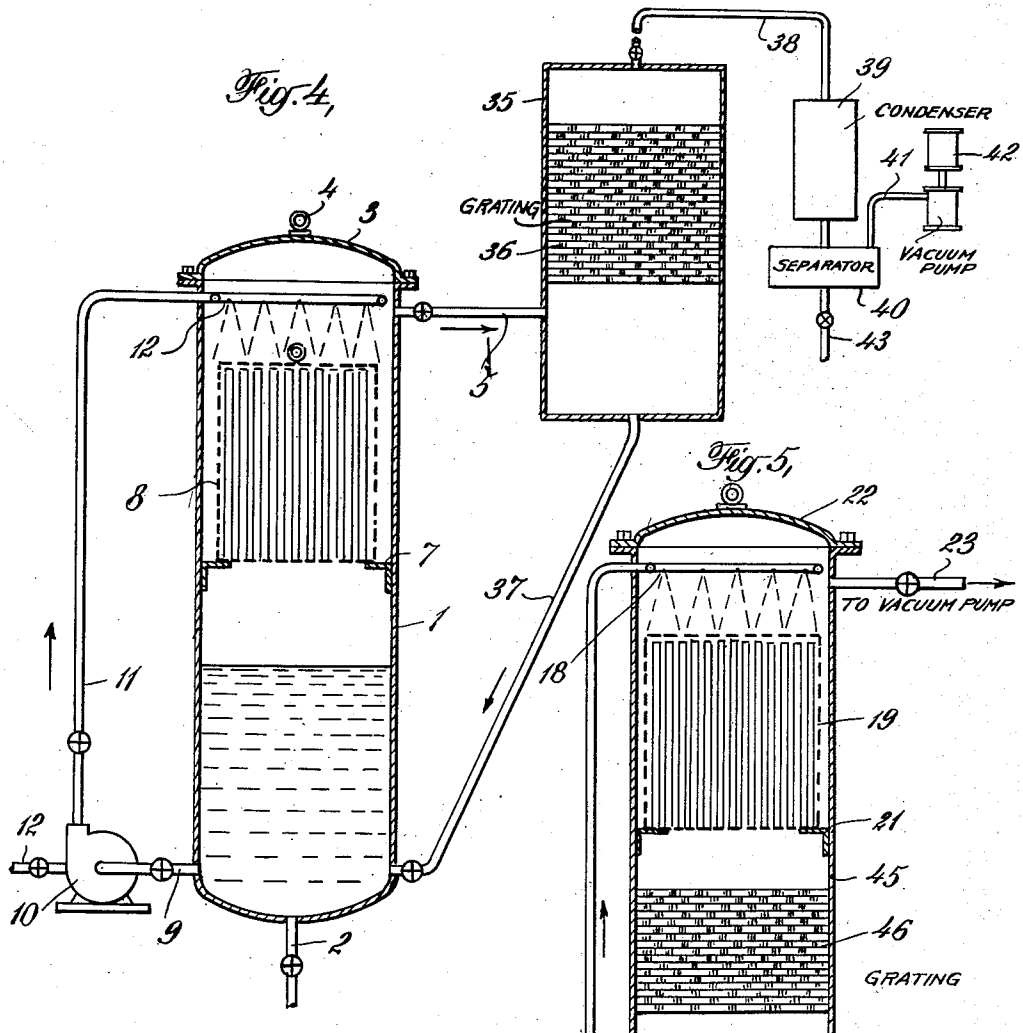


Fig. 5,

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Patented Sept. 3, 1935

2,012,970

UNITED STATES PATENT OFFICE

2,012,970

SATURATION OF ABSORBENT CONDUITS

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Application July 26, 1932, Serial No. 624,759

8 Claims. (Cl. 91—70)

This invention is directed to the saturation of absorbent articles, and particularly, the saturation and impregnation of fibrous conduits employed to conduct and protect underground cables, telephone lines, electric light, and other conductors, and for the formation of water and drain pipes to render them substantially waterproof and resistant to abrasion, corrosion, and conditions encountered underground by fibrous conduits. While, as above stated, the invention is particularly adapted for the saturation of fibrous conduits, it will be understood that it may be employed to saturate small fibrous or other articles requiring impregnation, such as spools, coils, or other preformed articles, asbestos products, concrete pipes, flashing blocks, and to impregnate and saturate wood.

The articles to be saturated may, of course, be prepared in any known manner. In the case of fibrous bases for conduits, newsprint and paper pulp, or other fibrous material, may be beaten in the usual paper beaters and the resultant stock screened and then pumped to paper cylinder machines and there formed into wet felts or paper. The wet paper may be wound about a cylindrical tube or mandrel to produce a wet conduit of proper thickness. This conduit may be dried in kilns to remove the major portion of its moisture content. The fibrous base may, of course, be prepared in other known manner. Such conduits are made in several sizes, commonly varying from two inches to six inches or larger in internal diameter, have an average wall thickness of approximately 3/8 of an inch and are usually produced in 5, 6, and 8 foot lengths. The wall thickness of the conduits may, of course, be greater or less than 3/8 of an inch and other dimensions may vary. As they come from the drying kilns, they usually contain from 5 to 8 per cent moisture, although considerably more than 8 per cent moisture may, on occasion, be found present.

The porosity or absorptive characteristics of the walls of fibrous conduits may vary within wide limits from a very dense wall of a density corresponding to hard wood and exceedingly difficult to saturate with low carbon water gas tar pitch or even with other waterproofing material, such as asphalt, to a porous open wall similar in density to that of roofing felt, which will readily absorb bituminous saturants. Samples of present commercial fibrous conduits have been tested and found to vary from substantially less than 1 cc. of voids per gram of tube wall to 2.8 or more cc. of voids per gram of tube wall. To determine the cubic centimeters of voids per gram of tube wall, a small sample of tube wall (say 2" x 5") is dried for one hour at 100° C., cooled, desiccated, and thereafter weighed. It is then immersed in kerosene, maintained at a temperature of 25° C., for 18 hours. Thereafter, the sample is removed from the kerosene drained in vertical position for 30 seconds, and again weighed. The difference in weight represents the kerosene absorbed. This difference in weight in grams, divided by the specific gravity of the kerosene, corresponds to the cubic centimeters of kerosene absorbed. This volume in cubic centimeters, divided by the original weight in grams, gives the voids in cubic centimeters per gram.

The fibrous conduits, as they come from the drying kiln, containing from 5 to 8 per cent of moisture, have heretofore commonly been impregnated with water gas tar pitch by immersing them in tanks of molten pitch maintained at atmospheric pressure or pressure above atmospheric and at a temperature of 275° to 300° F. or upwards. The conduits have in many cases been allowed to soak in the molten pitch for from 7 to 12 hours, then withdrawn, and permitted to drain to remove excess saturant therefrom.

This process of saturating fibrous conduits, it will be noted, requires the soaking of the conduits for long periods of time to obtain satisfactory penetration of the saturant throughout the walls of the conduit. In the practice of the process, numerous difficulties are encountered, among the most important of which may be mentioned—

(1) Foaming of the pitch during the saturation of the conduits with consequent loss of volatile oils from the pitch and restriction of the amount of pitch absorbed by the fibrous walls. This, I have found, may largely be attributed to the moisture content of the fibrous tubes. In the case of prior processes involving the maintenance of pitch in open tanks loss of volatile oils also occurs due to evaporation even without foaming.

(2) Building up of the "free carbon" content of the pitch due to the prolonged maintenance of large bodies of pitch in which the conduits are immersed under heat, resulting in decomposition of the pitch. Increase in the "free carbon" content of the pitch decreases the penetrability of the saturant and also results in carbon deposits on the walls of the conduit, preventing entrance of the saturant thereinto and resulting in defectively saturated conduits, i. e.,

conduits having "white spots" within the walls. The term "free carbon" is used in the sense common in the coal tar industry to indicate material contained in the bituminous saturant which is insoluble in benzol or carbon bisulfide. It is commonly determined as described by Weiss (Journal of Industrial and Engineering Chemistry, vol. 10, 1918, pages 736 and 820 Test D5). It comprises high-molecular weight carbon compounds of low solubility, carbon, and other insoluble material;

(3) Unsatisfactory saturation of the conduits due to the fibrous walls not absorbing sufficient saturant to render them substantially waterproof. Conduits which are not adequately saturated do not attain maximum strength and resistance to deflection or deformation;

(4) In the case of saturation of conduits under substantially atmospheric pressure, or under higher pressures, a substantial fire hazard may exist. This is especially the case where increased pressure is produced by air pressure on the saturant and where inadequately covered and protected saturating tanks are used; and

(5) Due to long time immersion of the organic or fibrous bases in hot saturant, charring or burning of the organic bases frequently takes place.

In order to satisfactorily protect cables and other electrical conductors, it is important that the fibrous conduit be substantially waterproof, resistant to abrasion and soil pressures, and capable of withstanding underground conditions and not punctured or broken by the soil and debris surrounding it. One of the tests to which conduits are subjected to determine their waterproofness is to immerse them in distilled water, maintained at a temperature of approximately 77° F. for 48 hours, then ascertain the percentage increase in the weight of the conduit and thus arrive at the amount of water absorbed thereby. Present conduits, saturated with water gas tar pitch, have been tested in this manner as many have been found to absorb in the neighborhood of 12 to 14 per cent of water. At the present time, it is generally recognized that a conduit which, upon immersion for 48 hours in distilled water maintained at a temperature of approximately 77° F., will absorb not more than 6 per cent moisture represents a satisfactory waterproof conduit; a conduit absorbing not more than 4 per cent moisture under these conditions is regarded as eminently satisfactory. It should be noted that as indicated hereinabove, many of the saturated fibrous conduits now made, when subjected to the waterproofness test briefly described above, show an absorption of moisture substantially in excess of 4 per cent, many of them absorbing 12 per cent and more moisture. In general, the lower the water absorption, the more satisfactory is the product.

It is an object of the present invention to provide a process for saturating absorbent articles, particularly fibrous conduits, which is simple and inexpensive to operate and requires the handling of minimum quantities of saturant for its practice. Only a relatively short time of contact between the saturant and fibrous base of the conduit is necessary, in accordance with this invention, to thoroughly impregnate the conduit. Hence, tendencies toward charring or burning of the organic bases of the conduits are substantially reduced.

In the impregnation of absorbent articles with bituminous saturant, two of the factors which tend to prevent satisfactory saturation are—

1. Air in the pores or voids, and

2. Moisture on the fibers or other solid surfaces and as vapor or even liquid in the pores.

Air and water vapor in the pores of the material tend to prevent entrance of the saturant, and water on the inner or outer material surfaces tends to prevent wetting of the surfaces by the saturant.

When saturation at atmospheric pressure is attempted, the major portion of the water may be removed by long soaking in the hot saturant at a temperature above the boiling point of water. The escaping steam carries with it some air. The removal of water by this means is time-consuming and air is ordinarily not completely removed. By the heretofore commonly practiced methods of saturation, relatively poor degree of waterproofness has been attained either because the voids of the saturated article are incompletely filled with saturant, or the fibers are incompletely surrounded by and wet with saturant. If it is attempted to improve the degree of saturation by applying pressure, some improvement is found, but saturation is still imperfect. The effect of pressure is, by forcing additional saturant into the material, to compress residual air and water vapor on the pores, even to the extent of somewhat compressing, densifying, and deforming the walls of the saturated article. On release of pressure, the compressed air and water vapor expand, forcing saturant out from the material, thereby reducing the degree and uniformity of saturation.

In accordance with a preferred embodiment of this invention, occluded gas and moisture are removed from the conduit walls by placing them in a saturating tank and evacuating the tank while heating it. In the preferred procedure of drying, I subject the conduits to be saturated, out of contact with the saturant, to a vacuum gradually increasing to a maximum, say 28 to 29 inches of mercury, and hold them at this vacuum while heating them long enough to remove substantially all water, water vapor, and air from the voids without allowing them to contact with the pitch saturant. The higher the vacuum obtained, the more effective is the removal of air and water from the voids and the more complete is the absorption of saturant.

When thus dehydrated and deaerated, I spray the conduits with pitch or other saturant. Spraying of the pitch over the conduits is continued for a considerable period of time depending on the porosity of the conduit walls, the saturant employed, etc. The vacuum is maintained on the conduits during spraying. Saturating fibrous conduits having approximately 1.6 cc. of voids per gram of tube wall with coal tar pitch of a specific gravity of about 1.2 at 60° F. and a melting point of 158° F. (cube in water) having a "free carbon" content of 6.4%, the pitch may be sprayed for from 1 to 3 hours or longer, over the conduit walls while maintaining vacuum thereon. When the saturation is completed the vacuum is broken, and the conduits permitted to drain and cool.

Continuous spraying of pitch over the conduit walls loosens and washes deposits of "free carbon" and other solid material therefrom. Continuous showering of saturant over the conduit while vacuum is maintained thereon provides an adequate supply of saturant at a minimum pressure head with respect to the conduit walls.

This results in minimum resistance to complete removal of air and water vapor and permits the substantially instantaneous entry, e. g., by capillary action, of a generous supply of pitch into the voids as the air is removed therefrom. This combination of favorable conditions results in completely saturated conduits, i. e., conduits having the voids filled with saturant, the fibers thoroughly wet with the saturant, and the conduit free from "white spots" or partially saturated sections.

Another substantial advantage of this process resides in the feature that a supply of pitch or other saturant of only a few gallons in excess of the amount which the conduits will absorb is required for the practice of this process since the conduits are not immersed in a bath of saturant as in prior procedures. Thus the maintenance of large excess supplies of pitch at high temperatures is avoided. Increase in "free carbon" content of pitch is minimized; a relatively great proportion of pitch circulated is absorbed by the conduits; losses of pitch are reduced to a minimum; and accumulation of lint, dirt and other detritus in the pitch is avoided.

Whereas in prior procedures, the amount of pitch in the saturating system was from 4 to 6 or more times as great as the weight of the conduits saturated during a period of twenty-four hours and as high as 75 to 100 times the weight of the conduits in the system at any instant, in the process of this invention, for very dense conduits in which 100 per cent saturation is accomplished, the pitch to conduit ratio at any instant may be as low as 0.5:1 and over a twenty-four hour period may be as low as 1.05:1. For more porous conduits, conduits which may absorb approximately from 200 to 260 per cent or more of saturant, based on the weight of the conduits, the amount of saturant in excess of that absorbed by the conduits required in the system may be correspondingly low.

Instead of drying the conduits in the preferred manner hereinabove described, the conduits may be soaked at atmospheric, or super-atmospheric, pressure, but preferably under vacuum in hot saturant, such as coal tar pitch or other bituminous waterproofing material, until foaming of the pitch stops and substantially all moisture is removed from the conduit walls. The pitch is maintained at a temperature materially above the boiling point of water effective during the drying of the conduits; for example, at a temperature of about 275° F. to 300° F. if atmospheric pressure be employed. If this procedure of drying the conduits is followed, existing equipment for saturating them, involving the soaking of the conduits in the hot saturant, may be employed to dry the conduits. After the conduits have been dried, they may be completely saturated under vacuum, as hereinafter more fully pointed out. The saturant employed may be the pitch in which the conduits were immersed to effect the drying or fresh water proofing saturant may be utilized.

My invention also contemplates the drying of the conduits by spraying the wet conduits with hot saturant until substantially all moisture has been evaporated. The conduits may be heated at atmospheric pressure, or higher pressures, and thereafter the conduits, while hot, subjected to vacuum, with heating if desired, to remove moisture and occluded gas therefrom, the sensible heat of the conduits aiding in, or effecting, the evaporation of water under the reduced pressure to which they are subjected.

The fibrous conduits may be dried by immersing them in the hot saturant under pressure of the order of 50 pounds gauge. The pressure may be gradually reduced during the soaking of the conduits so that the escape of air from the voids is facilitated. The saturant may then be drained from the tank, vacuum applied and the conduits sprayed as herein disclosed. Another mode of drying the conduits is by circulating heated air thereover until the drying is completed. Vacuum may then be applied to remove residual air from the conduit walls and thereafter the conduits sprayed with saturant while maintaining vacuum thereon. When the saturation is completed the vacuum may be broken, and the conduits drained and cooled. The conduits may be dried by heating them at atmospheric pressure with or without circulating air over the conduits.

The rate of removal of moisture from the conduits dried by spraying pitch thereover may be controlled by regulating the rate of spraying of the saturant and its temperature. With bituminous saturant the control will be quite sensitive due to low specific heat of saturant.

The wet conduits may be dried by contacting them with live steam. Thus the water in the conduits will be evaporated leaving steam in the voids. A vacuum will then be pulled on the conduits and steam and residual air removed from the voids, thus completly drying the conduits. After the initial steam treatment, heated air under pressure may be passed over the conduits. Upon release of the pressure the voids will be filled with air and steam and consequently the conduits will contain less steam than would be the case if steam alone were passed over the conduits. The air and steam may be removed from the conduits by subjecting the conduits to vacuum. The conduits may be subjected to vacuum while passing steam thereover to dry them. The rate of drying can be regulated by pressure built up with live steam, the rate at which the pressure is built up, etc.

In impregnating with other saturants, such as aqueous or alcoholic solutions or the like, the removal of volatile liquids immiscible with the saturant from the porous or the absorbent articles can be accomplished as herein described, thereby facilitating the wetting of the porous article by the saturant.

As the saturant for the fibrous conduits coal tar pitch, water gas tar pitch, asphalt, cutback pitches, blended pitches, or other waterproofing material may be employed. Preferably, a coal tar pitch having a melting point of from 140 to 180° F. is used to saturate the fibrous conduits. Pitch of a melting point as high as 225° F. may be used in special cases, e. g., where conduits are to be exposed to temperatures which would soften the lower melting point pitches. Preferred pitches having melting points of from 140 to 180° F. or higher will have a "free carbon" content of from 5 to 9 per cent, but pitches of higher "free carbon" content up to from 15 to 25 per cent, or even higher may be used to give commercially satisfactory saturation under favorable conditions, e. g., in saturating products having comparatively open wall structure.

Preferably, coal tar pitch made by a vacuum distillation process, such for example as disclosed in Patent No. 1,759,816, granted May 20, 1930, or other processes minimizing decomposi-

tion of the tar undergoing distillation, is employed as the saturant. Pitches made by a low temperature vacuum distillation process are characterized by low "free carbon" content as compared with pitches made by higher temperature processes from the same tar, and I have found that such pitches are particularly suitable as the saturant for fibrous conduits. For example, such pitch of 149° F. melting point (cube in water) when tested had a "free carbon" content of from 5 to 9 per cent; such pitch of 226° F. melting point (cube in air) had a "free carbon" content of from 11 to 15 per cent; and such pitch of 291° F. melting point (cube in air) when tested had a "free carbon" content of from 16 to 21 per cent. Pitches produced by distilling tar not under vacuum but by continuously heating the tar and then passing the heated tar into a vapor box where the vapors separate from the pitch have considerably higher "free carbon" contents for the same melting point pitch, e. g., pitch produced in this manner having a melting point of 149° F. (cube in water) when tested had a "free carbon" content of from 11 to 13 per cent; a pitch of 158° F. melting point (cube in water), had a "free carbon" content of from 10 to 14 per cent; a pitch of 226° F. (cube in air) had a "free carbon" content of from 19 to 23 per cent; and a pitch of 291° F. melting point had a "free carbon" content of from 33 to 37 per cent. The "free carbon" content will depend largely on the temperature treatment during distillation as well as on the melting point of the pitch and the "free carbon" content of the tar used to make the pitch. Coke oven tar generally will not run much above 5 per cent "free carbon"; 1 per cent "free carbon" content is relatively low for such tars.

The use of a pitch made by a vacuum distillation process for saturation has a two-fold advantage;

(1) In its manufacture, this pitch is distilled under vacuum and consequently at a lower temperature than would be needed to produce a pitch of the same melting point by the usual methods of distillation. This low temperature causes minimum decomposition and hence minimum "free carbon" formation in the pitch. Low "free carbon" content is an aid in effecting complete penetration and saturation of porous articles.

(2) In its manufacture, the pitch has been subjected to temperature and vacuum conditions such as to insure the substantially complete removal of oils which would be volatile under the conditions maintained in the saturating operation of my invention. Such pitches will be substantially free from oils volatile under the temperature and vacuum conditions encountered in the saturating operation, and consequently, will suffer minimum or at least only nominal losses from volatilization during saturation. Owing to low volatilization losses, concentration of "free carbon" resulting from oil losses as well as increases in melting point during saturation will be reduced to a minimum.

Other methods of manufacture, such as steam- or inert-gas-distillation, which effect distillation at relatively low temperatures, will yield desirable pitches for my process for the reasons outlined above.

While my invention is particularly adapted to saturating absorbent articles with waterproofing material in a molten condition, it is likewise adapted to saturating with waterproofing compounds dissolved to form liquid solutions in solvents by observing the proper temperature, pressure and time conditions. Such materials may be natural resins (e. g., rosin), drying oils (e. g., linseed, tung oil, etc.), synthetic resins (e. g., paracoumarone resin, phenol-formaldehyde resin, etc.); plasticizers and modifying agents may be added. The solvents used may be chosen to meet requirements for the waterproofing material used, the temperature of saturation and vacuum and other working conditions; such solvents may be benzol, toluol, solvent naphthas, petroleum naphtha, or other fractions, alcohols, chlorinated hydrocarbons, natural oils, etc.

Besides waterproofing absorbent articles, this invention may be employed in fireproofing, oil proofing, gas proofing, insulating, painting and coloring such articles. For example, in fireproofing the article it may be impregnated with an aqueous solution of inorganic salts, e. g., solutions comprising phosphates; in oil proofing, a resin or cellulose solution may be used; in gas proofing and insulating, the article may be saturated with resin, cellulose or rubber mixture; and in painting and coloring, the article may be impregnated with paints, lacquers, enamels, or varnish. The invention may also be applied to the preserving of wood by impregnation of the wood with creosote or aqueous solution of fungicidal salts.

After the tubes have been sprayed for fifteen minutes or more with saturant while maintained under vacuum, the spraying may be interrupted and the tubes subjected to vacuum out of contact with the sprayed saturant. This permits saturant to drain from the tubes and the removal of residual gas and moisture from the tube walls. The fibrous tubes may be subjected to vacuum out of contact with the sprays of saturant for a predetermined period of time which may be as short as one or two minutes and may, if desired, be for longer periods, e. g., for one or more hours. Thereafter saturant is again sprayed onto the tubes. In this way removal of a maximum proportion of occluded gas and moisture and the absorption of a maximum amount of saturant by the fibrous tubes is insured; a uniform and thoroughly saturated tube results.

As a modification of the procedure hereinabove described, after the initial spraying of the fibrous tubes under vacuum, the vacuum may be broken and the pressure gradually permitted to build up to atmospheric in the saturating tank during the spraying. The spraying is continued while the tubes are subjected to the atmospheric pressure then prevailing. The tank may then again be evacuated while the spraying is continued. Thereafter, the spraying may be interrupted and the saturated tubes subjected to vacuum for any desired period. After this vacuum treatment, the tubes may be again sprayed with saturant until completely saturated. If desired, after the saturation of the fibrous conduits under vacuum, as hereinabove described, the vacuum may be broken and pressure, which may be up to 100 pounds per square inch, built up on the partially saturated conduits by introducing an inert gas into the saturating tank. The inert gas is introduced slowly so that the pressure builds up gradually in the tank. While the conduits are subjected to pressure, additional saturant may be sprayed thereonto. Operation in this manner is particularly suited to the saturation of very dense conduits. The pressure on the partially saturated conduits during the spraying thereof and after the conduits have been subjected to vacuum saturated as hereinabove described

causes the introduction of maximum amounts of saturant into the conduit walls.

In the preferred embodiment illustrated in the drawings, the invention is shown incorporated in the production of a fibrous conduit saturated with a bituminous material and the present disclosure will be confined to the present illustrated embodiment of the invention. It will be understood, however, that the novel features and improvements are susceptible to other applications, such, for example, as the saturation of absorbent articles generally. Included in the scope of my invention is the saturation of conduits, piping and other conductors made of cement, concrete, cement-asbestos mixture, or other porous or absorbent articles capable of being saturated. The conduits produced by my process are not only resistant to external pressures, such as soil pressures, but by suitable choice of materials and saturating conditions, may be made resistant to high internal pressures and hence suitable for pipe lines conveying corrosive waters or the like. Hence, the scope of this invention is not confined to the specific embodiment herein described.

In the drawings, Fig. 1 is a vertical section, partly in elevation, of one form of apparatus for practicing the process of this invention;

Fig. 2 is a vertical section, partly in elevation, of a modified form of apparatus for practicing the process of this invention;

Fig. 3 is a vertical section, partly in elevation, of still another modified form of apparatus for practicing the process of this invention;

Fig. 4 is a vertical section, partly in elevation, of a further modified form of apparatus for practice of the process of this invention, the apparatus of this figure being particularly designed for the handling of wet conduits which upon contact with pitch cause excessive foaming of the pitch to take place; and

Fig. 5 is a vertical section, partly in elevation, of a further modified form of apparatus for practicing the process of this invention.

In Fig. 1, reference numeral 1 indicates a saturating tank having at its base a valve-controlled draw-off 2. This tank is provided with a cover 3 arranged to effectively seal the top of the tank. Cover 3 is provided with a hook or eye 4, permitting ready removal from and placement onto tank 1. Tank 1 is connected by a pipe 5 to a vacuum pump (not shown). A heating jacket 6 surrounds tank 1 and may be heated by steam, hot gases, or otherwise.

Brackets 7 are suitably secured to the sides of tank 1 at a point intermediate the ends thereof. These brackets function to support cage or basket 8 designed to maintain fibrous conduits or other articles to be saturated in vertical position as shown in Fig. 1. Leading from the base of tank 1 is a pipe 9 communicating with a pump 10 which in turn is disposed in a pipe line 11 connected to a spray head 12 positioned in the top of tank 1. Spray head 12 may be arranged to one side of the basket of conduits 8 and the sprays thereon disposed to direct the saturant to completely cover the basket. As an alternative, spray head 12 may be swivelled in tank 1 so that it can be moved into a position to one side of the basket permitting the ready removal from and placement of the basket into tank 1 and during operation disposed directly above the basket 8. A valve-controlled pipe line 12 leads into the inlet side of pump 10 for delivering additional saturant to the spray head 12.

In operation of the apparatus of Fig. 1, the fibrous conduits to be saturated, preferably in vertical position, are placed in perforated basket or cage 8 and the basket then inserted into the saturating tank 1, resting on supports 7. Thereafter cover 3 is suitably sealed onto the saturating tank. The vacuum pump is started causing the vacuum to gradually build up in the tank 1 and the tank heated by means of steam jacket 6 simultaneously with the building up of the vacuum. Preferably, before heating the tank, a limited amount af saturant is admitted thereinto. The saturant in the base of the tank serves to prevent local overheating of the tank walls during the heating to drive out the moisture and occluded gas from the fibrous conduits and also prevents overheating of the fibrous conduits in cases where the tank is heated by direct flame or fire. A vacuum of from 17 to 29 inches of mercury, preferably above 26 inches of mercury, may be maintained during the drying of the conduits. The heating of the conduits under vacuum is carried on until moisture and occluded gas are removed therefrom to the maximum practicable degree. Just how long this should take depends upon the porosity of the conduits, their initial moisture content, etc. For a fibrous conduit having about 1.6 cc. of voids per gram of tube wall and having a moisture content of approximately 5 to 6 per cent, heating from about 45 minutes to 2 hours should suffice. The optimum temperature in the container or saturating tank during the drying of the conduits will depend upon the percentage of water, size of voids, density of the material, time cycle, and other factors. In one case, 140° F. was found to be satisfactory with a vacuum of 27 inches of mercury when drying conduits containing approximately from 5 to 8 per cent moisture and having 1.6 cc. of voids per gram of tube wall.

After the moisture and occluded gas have been removed, bituminous saturant is pumped by pump 10 through spray head 12, completely showering the basket and the contained conduits. The conduits or tubes are continuously showered with the saturant for the required period of time, fifteen minutes or longer, the saturant flowing into the base portion of the tank where it is withdrawn by the pump 10 and returned to the sprays 12. After the spraying is continued for a period of approximately fifteen minutes, or longer, the vacuum may be broken and the pressure permitted to gradually build up to atmospheric. The spraying is continued during this period and the conduits are continuously sprayed at atmospheric pressure until they are completely saturated.

The spraying may be interrupted during the saturation of each group of conduits under vacuum so that the conduits are intermittently subjected to vacuum, a spray of saturant while the conduits are subjected to vacuum, to vacuum out of contact with the pitch spray, etc. After the conduits have been partially saturated under vacuum, as hereinabove described, they may be subjected to atmospheric pressure or pressure above atmospheric while being sprayed with saturant and while out of contact with the sprays of saturant. Pressure above atmospheric may be created by introducing a suitable inert gas into the saturating tank.

The apparatus of Fig. 2 differs from that of Fig. 1 chiefly in that the base of a saturating tank 13 communicates through a long conduit or pipe 14 with a container 15 for saturant. Pipe 14 is of a length sufficient to accommodate a maximum barometric column of saturant. When using coal

tar pitch having a specific gravity of 1.2 as the saturant, pipe 14 should be at least 28 feet long; i. e., long enough to accommodate a barometric leg of pitch. Container 15 is provided with a valve-controlled inlet 16 for pitch and communicates with a pump 17 connected to spray head 18 for spraying the pitch or other saturant onto the basket or cage 19 containing the conduits. Supports 21 for the basket or cage 19 are suitably secured to the sides of saturating tank 13 near the base thereof. The saturating tank 13 is provided with a cover 22 and communicates by means of pipe 23 with a vacuum pump (not shown). A steam jacket 24 or other suitable heating means may be associated with the tank.

The liquid saturant in pipe 14 and tank 13 provides a liquid seal for the saturating tank 13 and insures that the base portion of the saturating tank is effectively sealed against the atmosphere. In the case of the apparatus of Fig. 2, it will be noted that leakage through pump 17 does not affect the vacuum maintained in saturating tank 13.

The saturating procedure practiced with the apparatus of Fig. 2 is substantially as herein described in connection with the procedure followed in the operation of the apparatus of Fig. 1.

Fig. 3 shows equipment for saturating a plurality of banks of vertical tubes simultaneously. This apparatus involves a horizontally elongated saturating tank 25 having at its sides supporting and guiding rails 26 for maintaining baskets or cages 27 disposed at spaced intervals within the tank 25. A suitable gas-tight cover 28 is provided for the open end of tank 25. Extending through suitable packed joints in the tank are pipes 29 each communicating with a spray head 30. Pitch or other saturant is supplied from a pump (not shown) to a valve-controlled pipe 31 communicating with pipes 29. Excess pitch sprayed over the perforated or foraminous baskets 27 drains to the base of tank 25 and may be withdrawn through a valve-controlled pipe 32 communicating with a tank not shown. Pipe 33 connects the tank 25 with a vacuum pump (not shown). The saturating tank 25 of Fig. 3 may be liquid sealed as in the case of the apparatus of Fig. 2.

In lieu of saturating a single basket of conduits, as in the apparatus of Figs. 1 and 2, 6 baskets, or any desired number, may be dried and saturated simultaneously in the apparatus of Fig. 3. The drying and saturating procedures may be substantially the same as hereinabove described for a single basket. Heating and recirculating means, such as shown and described in connection with Figs. 1 and 2 may be employed with the apparatus of Fig. 3.

The apparatus of Fig. 4 is particularly designed to handle wet conduits which cause excessive foaming of the pitch saturant upon contact therewith. This apparatus closely resembles that of Fig. 1 and corresponding parts in these two figures have been given like reference numerals. For the sake of clearness, the heating jacket surrounding the saturating tank has been omitted from Figs. 4 and 5.

Referring to Fig. 4, pipe 5 leads from the saturating tank 1 to a foaming chamber 35. This chamber is provided with suitable grating 36, such as the grates known commercially as "subway grating". Any type of grating providing for intimate contact between the foam passing into chamber 35 from saturating tank 1 and the grating and resulting in the decomposition of the foam may be employed. Passage of the foam through the grating 36 results in the destruction of the foam, the oil or saturant content of the foam being returned to tank 1, if desired, through valve-controlled pipe 37 and the gas and vapors leaving the chamber 35 through valve-controlled pipe 38. Pipe 38 leads into a container 39 in turn communicating with an oil and water separator 40. A pipe 41 connects the separator 40 with the vacuum pump 42. The separator is provided with valve-controlled draw-offs, such as indicated at 43, for removing the oil and water content therefrom. It is noted that the showing of Fig. 4 is diagrammatic in character and in practice the condenser 39, separator 40 and vacuum pump 42 will be located at a level above the top of foam chamber 35.

Reference numeral 45, in Fig. 5, designates an elongated saturating tank having below the supports 21 for the basket 19 suitable grating, such as "subway grating", indicated by the reference numeral 46. The apparatus of Fig. 5 otherwise is of the same general type as that of Fig. 2 and like parts have been given corresponding numerals. Upon the spraying of the wet conduits with coal tar pitch or other saturant, the foam thus generated passes with the excess pitch through the grating 46. The foam is decomposed, the oil or saturant content thereof settling to the base of the tank 45 and the gas and vapor content leaving the tank through pipe 43.

In the operation of the apparatus of Figs. 4 and 5, the wet conduits are placed in vertical position in baskets 8 or 19, as the case may be, which are disposed within the saturating tank resting on the supports provided therefor. The tank is then sealed and hot saturant sprayed over the conduits. Atmospheric pressure may be maintained in the tank during the drying of the conduits. Preferably, a vacuum is pulled on the tank so that the drying is carried out under vacuum and thus facilitated. The foam generated in the case of the apparatus of Fig. 4 is destroyed in chamber 35, the saturant content being returned to the saturating tank 1 through pipe 37. In the apparatus of Fig. 5, the foam is destroyed in its passage through the grating 46, the oil settling to the base of the tank and the gas and vapors leaving the tank through pipe 23.

In the specification and drawings, the saturation of conduits while maintained in a vertical position has been described and shown. Such position of the conduit has several advantages and is, therefore, preferred, but it will be understood that the conduits during drying and saturation may be maintained in a horizontal position or a position inclined to the horizontal. Among the advantages of maintaining the conduits in vertical position may be mentioned, the necessary apparatus occupies smaller floor space, ready egress of air from the wall of the conduit is permitted, contact of the saturant with the conduit walls is facilitated, and tendency of the conduit to bend or deform is lessened. Settling of "free carbon" on horizontal surfaces is also obviated.

The process of this invention results in a more thorough saturation of the fibrous conduits; requires materially less time for efficient saturation and impregnation; and involves comparatively simple and compact apparatus for its practice. This process reduces to a minmium per conduit the amount of saturant required to be in the system and reduces the time of contact between the hot pitch or other saturant and the conduit. Hence, charring or burning of the organic bases

of the conduits, frequently occurring in prior practice involving long time immersion of conduits in hot saturant, is decreased in the process of this invention.

I claim:

1. The process of saturating a fibrous conduit with coal tar pitch which comprises heating the conduit and simultaneously subjecting it to vacuum to remove moisture and occluded gas therefrom, and thereafter spraying the conduit with coal tar pitch while maintaining said vacuum so that the coal tar pitch enters and fills the voids of the conduit.

2. The process of saturating fibrous conduits, which comprises spraying the conduits with saturant while maintaining a pressure below atmospheric in the saturating zone, and thereafter increasing the pressure in the saturating zone to at least atmospheric pressure while continuing the spraying of the conduits with the saturant.

3. The process of saturating fibrous conduits, which comprises spraying the conduits with coal tar pitch while subjecting the conduits to vacuum and thereafter increasing the pressure in the saturating zone to at least atmospheric pressure while continuing the spraying of the conduits with coal tar pitch.

4. The process of saturating conduits having relatively rigid walls of substantial thickness and density and constituted of organic fibrous material, with a bituminous saturant containing free carbon and in heat liquefied condition and which saturant when in heat liquefied condition at saturating temperatures upon prolonged contact with the conduits would cause substantial thermal deterioration of the walls thereof which process comprises subjecting the conduits to vacuum, while under vacuum spraying the conduits with a bituminous saturant in heat liquefied condition at an elevated temperature, whereby any deposits of free carbon forming on the conduit walls are loosened and washed off during the said spraying, the voids are substantially completely filled with the saturant and prolonged contact of the conduit walls with hot saturant is avoided with consequent elimination of substantial thermal deterioration of the conduit walls.

5. The process of saturating conduits having relatively rigid walls of substantial thickness and density with a bituminous saturant in heat liquefied condition which comprises introducing conduits in a zone of reduced pressure below atmospheric pressure, subjecting the conduits to heat while in said zone of reduced pressure to remove moisture and occluded gas from the walls of said conduits, thereafter spraying the conduits with said bituminous saturant in heat liquefied condition while maintaining them in said zone of reduced pressure and continuing the spraying of said conduits until the voids in the walls are substantially completely filled with saturant.

6. The process of saturating absorbent articles which comprises introducing the articles in a zone maintained under vacuum, spraying the articles with liquid saturant so as to continuously wash the articles with the liquid saturant while maintaining vacuum conditions in said zone thereby preventing the formation of a layer of solid material on said absorbent articles and thus facilitating the penetration of the saturant into the articles, interrupting the spraying and subjecing the articles to vacuum conditions in said zone and thereafter again spraying the articles with saturant while maintaining said vacuum conditions.

7. The process of saturating conduits having relatively rigid walls of substantial thickness and density and constituted of organic fibrous material with coal tar pitch containing free carbon and in heat liquefied condition and which saturant upon prolonged contact with the conduits at saturating temperatures would cause substantial thermal deterioration of the walls thereof which comprises subjecting the conduits to vacuum conditions and while under vacuum spraying the conduits with coal tar pitch in heat liquefied condition at an elevated temperature, whereby deposits of free carbon on the conduit walls are loosened and washed off during the said spraying, the voids are substantially completely filled with saturant and prolonged contact of the conduit walls with hot saturant is avoided with consequent elimination of substantial thermal deterioration of the conduit walls.

8. The process of saturating conduits having relatively rigid walls of substantial thickness and density and constituted of organic fibrous material, with coal tar pitch containing free carbon which comprises subjecting the conduits to vacuum conditions and while maintaining the conduits under vacuum spraying the said coal tar pitch saturant thereon, whereby the formation of an impenetrable layer of free carbon on the surface of the fibrous conduits is prevented and the saturant enters and fills the voids in the conduit walls.

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