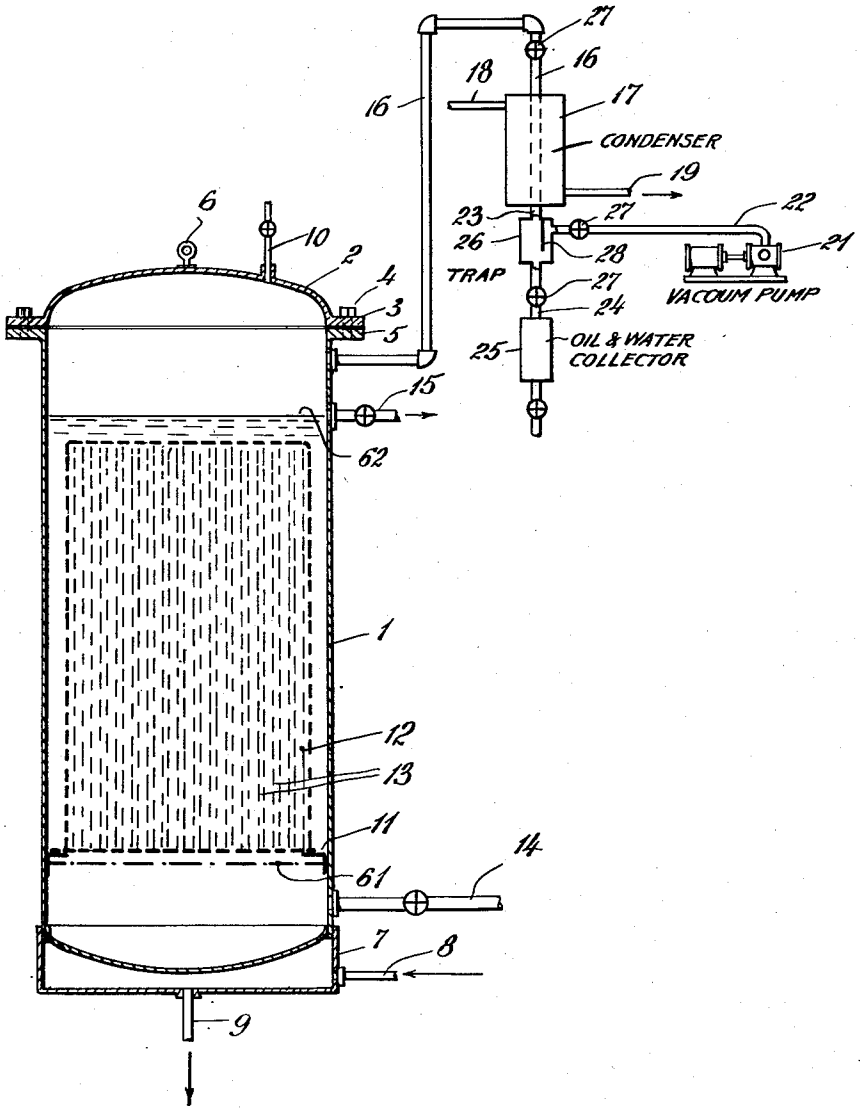
Sept. 3, 1935. G. EMBERG 2,012,961

PROCESS OF SATURATING FIBROUS CONDUITS

Filed May 27, 1932 2 Sheets-Sheet 1

Fig. 1,



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PROCESS OF SATURATING FIBROUS CONDUITS

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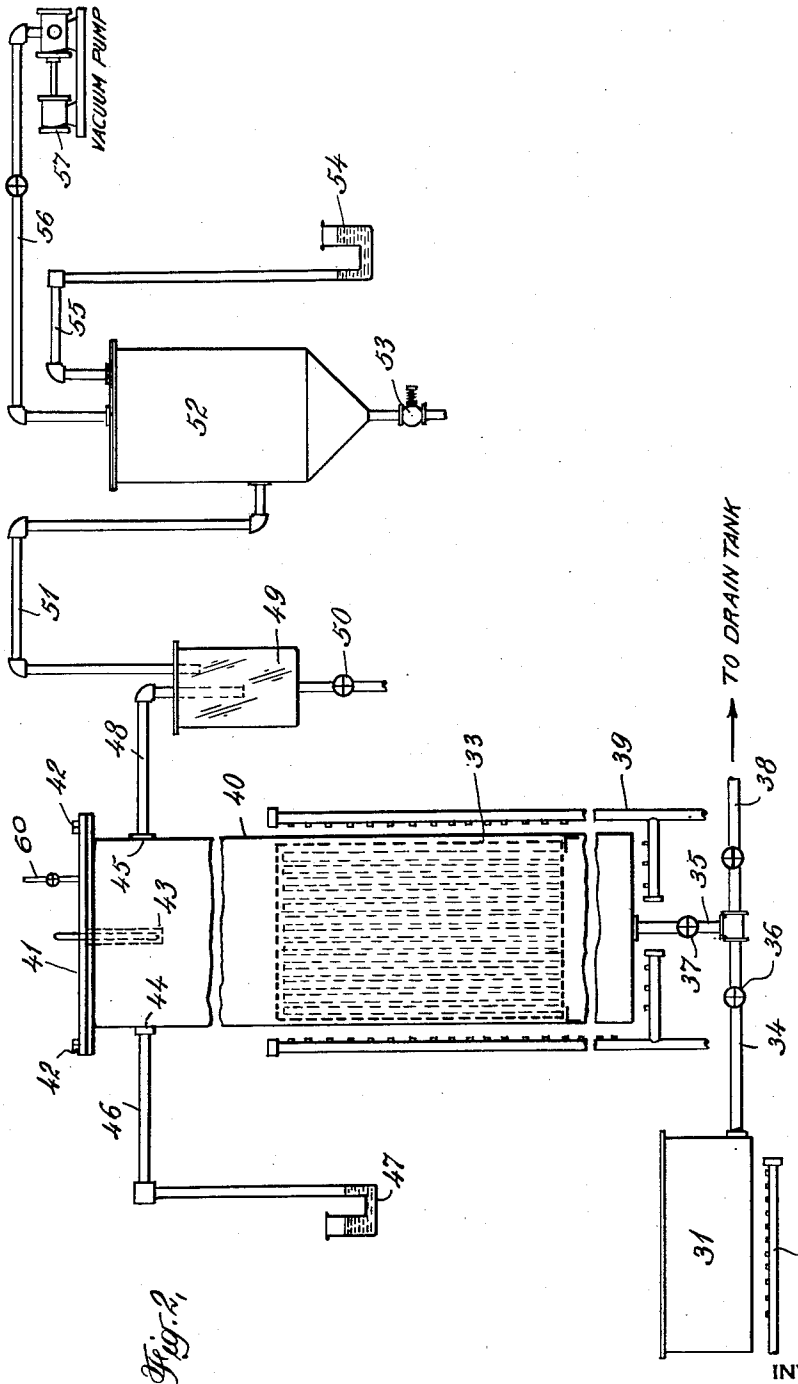


Fig. 2.

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Patented Sept. 3, 1935

2,012,961

UNITED STATES PATENT OFFICE

2,012,961

PROCESS OF SATURATING FIBROUS CONDUITS

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Application May 27, 1932, Serial No. 613,937

6 Claims. (Cl. 91—70)

This invention is directed to the saturation of absorbent products, and more particularly, to 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 drain pipes utilized for the discharge of corrosive liquids to render them substantially waterproof and resistant to abrasion, corrosion, and conditions encountered underground by fibrous conduits.

The fibrous bases of the conduits for the preferred embodiment of my invention may be prepared in any well known manner. For example, 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, varying from 2 inches to 6 inches or larger in external diameter, have an average wall thickness of approximately ⅜ 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 ⅜ 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 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;

(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 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; and

(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 incompletely covered and protected saturating tanks are used.

Water gas tar pitch has heretofore largely been

employed as the saturant for fibrous conduits. As is well known, water gas tar pitch is obtained by distilling tar derived from carburetted water gas made by enriching blue gas with products of pyrogenic decomposition of petroleum oils. The oils constitute the chief source of tar present in the carburetted water gas. Water gas tar pitch is, therefore, essentially of petroleum origin and it is recognized that water gas tar pitch differs materially in composition from other pitches, particularly coal tar pitches derived from the distillation of tar obtained from coal distillation gases. Water gas tar pitch has been employed for saturating fibrous conduits largely because of its relatively low "free carbon" content (about 2 to 7 per cent); its improved waterproofing properties as compared with asphalt; and its capability to protect the fibrous base against molds and fungi. While in some cases asphalts have been employed for the saturation of conduits, generally speaking, they are less satisfactory than pitch in that they are less waterproof and do not effectively withstand and protect against molds and fungi and other cellulose destroying organisms.

In order to satisfactorily protect cables and other electrical conductors, it is important that the 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 and many have been found to absorb in the neighborhood of 12 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 of making a saturated fibrous conduit in which the voids are substantially completely filled with saturant, and which upon immersion in distilled water for 48 hours at a temperature of 77° F. will absorb substantially less than 4 per cent moisture. A further object is to provide a process of making fibrous conduits which are more resistant to corrosion, to deflection and deformation stresses, to abrasion, and to soil pressures than known conduits, and the walls of which are of greater tensile strength than those of known conduits. It is another object of this invention to provide a process of saturating fibrous conduits which permits the employment of coal tar pitch as the saturant. Other objects and advantages of this invention will appear from the following detailed description.

In the impregnation of porous 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 in the pores.

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

When saturation is attempted at atmospheric pressure, 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 not completely removed. By the heretofore commonly practiced methods of saturation, therefore, the voids of the saturated article are incompletely filled 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 in 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 pitch out from the material, thereby reducing the degree of saturation and even distribution of the saturant.

My invention largely or entirely eliminates these disadvantages and produces an article the voids of which are nearly or completely filled with saturant. Such articles are more resistant to water-absorption, abrasion, deflection, and deformation. In the process of my invention, the walls of the fibrous conduits are not subjected to pressure or other conditions which would cause densification or compression of the tube walls with consequent increased resistance to absorption of saturant, but on the contrary the pores or voids are evacuated, materially increasing the absorbing capacity of the tube wall.

In accordance with this invention, the conduits are first dried. This is preferably accomplished by placing them in a basket in a container. The container is then heated and subjected to vacuum, which may preferably be of the order of from 17 to 29 inches of mercury and may be maintained for from a few minutes to two hours or more, depending upon the amount of water, the structure of the conduit walls, etc. Thus, substantially all moisture and occluded air and other gas are removed from the conduit walls. Molten waterproofing saturant, preferably of a bituminous nature, is then progressively introduced into the container until the conduits are completely immersed. Maintenance of the vacuum on the conduits during the gradual addition of the bituminous saturant permits the saturant to enter the evacuated voids or pores immediately upon contact with the walls of the conduit; prior removal of the moisture and air precludes foaming. Hence, thorough saturation of the conduit readily takes place and the conduit walls absorb considerably more saturant than is possible with other methods of saturation or impregnation. After the conduit is completely immersed in the saturant, the vacuum may be interrupted and the conduits permitted to soak for as long as 45 minutes or longer.

In my preferred procedure of drying, I subject the conduits to be saturated 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. When thus dehydrated and deaerated, I permit pitch to come into contact with them. Even while the pressure head on any given point of the tube due to the level of pitch in the tank is low, the capillarity of the pores causes a considerable amount of pitch to be absorbed. Increase of pressure head of the pitch forces additional amounts into the vapor- and air-free voids, effecting substantially complete saturation.

Slow increase of head of pitch has the added advantage of permitting satisfactory saturation with saturants containing fine suspended matter like the "free carbon" of coal tar pitch. Slow increase in pressure (as is well known in the filtering art) tends to eliminate the building up of impenetrable layers of such suspended matter (e. g. "free carbon") on the surface of the fiber conduit, and by eliminating such layers, assures greater penetration and improved saturation.

The higher the vacuum attained, the more effective is the removal of air and water from the voids and the more complete is the absorption of saturant.

I have discovered that coal tar pitch, preferably a pitch having a melting point of from 140 to 180° F., can in accordance with the process of this invention, be employed as the saturant. Pitch of a melting point as high as 225° F. may be employed in special cases, e. g. with conduits having large size voids. 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 unusually open 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 decomposition 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 and I have found that such pitches are particularly suitable as the saturant for fibrous conduits. For example, such a pitch of 149° F. melting point (water bath) had a "free carbon" content of from 5 to 9 per cent; such pitch of 158° F. melting point (water bath) had a "free carbon" content of from 5 to 9 per cent; such pitch of 226° F. melting point (air bath) had a "free carbon" content of from 11 to 15 per cent; and such pitch of 291° F. melting point (air bath) 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 proof 149° F. (water bath) had a "free carbon" content of from 11 to 13 per cent; a pitch of 158° F. melting point (water bath), had a "free carbon" content of from 10 to 14 per cent; a pitch of 226° F. (air bath) 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 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 very 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 material.

(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 non-volatile at the temperature and vacuum conditions encountered in the saturating operation, and consequently, will suffer minimum or substantially no loss from volatilization during saturation. Owing to low volatilization losses, increase in "free carbon", as well as change 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.

In the preferred embodiment, illustrated on the drawings, the invention is shown incorporated in the production of a fibrous conduit saturated with a bituminous saturant 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 products 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 materials capable of being saturated with waterproofing compounds. 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 improvement herein described.

In the drawings, Fig. 1 is a side elevation, partly in section, illustrating the apparatus for saturating conduits; and

Fig. 2 is a side elevation of a modified arrangement of apparatus for saturating conduits.

In the drawings, Fig. 1, reference numeral 1 indicates a saturating tank or container, preferably of an over-all height of approximately 5 feet in excess of the length of the conduits or tubes to be treated. A cover 2 has a flange 3 arranged to be bolted or otherwise secured against vacuum leakage, as indicated at 4, to flange 5 on container 1. In lieu of bolting the cover to the container, flanges 3 and 5 may be

ground to form a gas tight joint when properly assembled. Cover 2 has a hook or eye 6 to permit ready removal from and placement onto the tank 1.

The bottom of the container is shown provided with a steam jacket 7 having steam inlet 8 and outlet 9 for supplying heat to the tank 1, although other heating means may be employed. At a point near the base of the container, a screen or other suitable support 11 is provided for a basket 12 containing the conduits 13 to be impregnated. Heat insulating material (not shown) may be disposed about the tank and other parts of the apparatus to reduce heat losses therefrom.

Saturant is supplied to the tank 1 through valve-controlled pipe 14, disposed at the base of the tank. An overflow pipe 15 is connected to a side wall of the tank near the top thereof. This pipe may communicate with a storage tank (not shown) for the saturant. Extending through the side of tank 1, through a gas-tight packed joint, is a pipe 16. This pipe is communicably connected with condenser 17 having inlet 18 and exit 19 for cooling water or other medium. A suction pump 21 of any suitable type is connected by pipe 22 with the trap 26 into which leads section 23 of pipe 16. A baffle 28 in the trap 26 prevents flow of liquid through the trap into the vacuum line 22. Pipe 24 connects trap 26 with oil and water collector 25. Valves 27 are disposed in pipe lines 16, 22, and 24 to control flow therethrough.

In the arrangement of apparatus shown in Fig. 2, 31 indicates a melting kettle which may be suitably heat insulated. Burners 32 are provided beneath the kettle to heat the contents thereof. Kettle 31 communicates with saturating tank 40 by means of pipes 34, 35 having valves 36, 37 therein, pipe 35 leading into the base of the vertical tank 40. A valve-controlled discharge pipe 38 communicates with pipe 35 and leads to a storage tank (not shown) or other point of disposal of residual pitch in saturating tank 40. The tank 40, as indicated on the drawings, is of a relatively great height and is provided with suitable supports for basket 33 containing the fibrous conduits to be saturated.

Tank 40 may be heated directly by burners 39 disposed about its sides and base or may be steam heated, e. g., by steam coils. Gaseous or liquid fuel may be fed to these burners. Cover 41 seals the top of the tank. In Fig. 2, the cover is shown as bolted to the tank, as indicated by reference numeral 42, a gasket being inserted between the cover and flange of the tank to give a gas-tight joint. A thermometer-well 43 is formed in the top of the cover. Ports 44 and 45 are formed in the sides of the saturating tanks. Port 44 communicates, by means of pipe 46 with a mercury barometer 47 or other pressure indicating device to show the vacuum in the saturating container. The other port 45 is connected through pipe 48 with a receptacle 49, permitting visual inspection of any distillate which may come over from the saturating tank 40. A valve-controlled drain pipe 50 leads from receptacle 49 permitting removal of the contents of the receptacle.

Pipe 51 connects the receptacle 49 with a safety tank 52. This tank functions to collect any foam coming from the saturating tank and prevents the entrance of this foam into the vacuum line. Discharge of the contents of tank 52 may be effected through valve-controlled pipe 53. A mercury barometer 54 or other pressure indicating device communicates by means of pipe 55 with the safety tank 52. Valve-controlled pipe 56 connects tank 52 with the vacuum pump 57.

In operation, the fibrous conduits to be saturated are placed in a perforated basket, preferably though not necessarily in vertical position, and the basket then inserted in the saturating tank, being supported therein somewhat above the base of the tank. As indicated in Figs. 1 and 2, the tanks are of an over-all height such that a considerable open space is provided above the top of the conduits. Thereafter, the cover is suitably sealed onto the saturating tank. The vacuum pump is started and the container or saturating tank heated simultaneously with the generation of the vacuum. In the case of the apparatus of Fig. 1, this is accomplished by passing steam through the jacket 7. In the apparatus of Fig. 2, the container is heated by direct fire from burners 39. Preferably before heating the container, saturant is admitted thereto to a level just below the bottom of the tubes as indicated by the line 61 on Fig. 1. The saturant in the base of the container prevents destruction of the container walls during the heating thereof to drive out the moisture and occluded gas from the fibrous conduits and prevents over-heating of the fibrous conduits.

A vacuum of from 17 to 29 inches of mercury, preferably about 27 inches of mercury, may be maintained during the drying of the conduits, although lower vacuum may, of course, be employed. The heating of the conduits under vacuum is carried on until substantially all moisture and occluded gas are removed therefrom. Just how long this should take depends upon the porosity of the conduit, their initial moisture content, etc. For a fibrous conduit having about 1.6 cc. of voids per gram of tube wall and containing a moisture content of approximately 5 to 6 per cent, heating for from 45 minutes to 2 hours should suffice. The optimum temperature in the container or saturating tank during the drying of the conduit 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. voids per gram of tube wall.

After the moisture and occluded gas have been removed, the saturant is gradually added through pipe 14 (Fig. 1) or through pipes 34 and 37 (Fig. 2) while the vacuum is maintained on the fibrous conduits. Utilizing coal tar pitch having a melting point of about 158° F., having a "free carbon" content of about 6 per cent, and a specific gravity of about 1.23 at 25° C., the pitch is maintained in the saturating kettle at a temperature of about 320° F.

In the case of the apparatus of Fig. 2, the flow of the saturant is controlled by regulating valve 37, the suction on the container causing the saturant to gradually rise thereinto. The rate of flow of the saturant into the container or tank and the vacuum maintained therein may be controlled so that a substantially constant suction is maintained on the saturant as it rises in the tank. Flow into the apparatus of Fig. 1 is controlled by manipulation of the valve in line 14 or regulating the speed of the pump communicating with pipe 14. This flow may be so regulated that it takes from 15 minutes to an hour for the saturant to rise to a level above the tops of the

conduits, indicated by the line **62** in Fig. 1. Thereafter, the vacuum may be interrupted, or if desired maintained while the fibrous conduits soak in the saturant. The period of soaking in the case of less dense tubes or conduits may be varied from 45 minutes to 2 hours; a longer period may be required for more dense tubes. During entrance of the saturant into the tanks, the vacuum pump may be operated to maintain a substantially constant suction on the conduit walls, thus permitting the saturant to enter the evacuated pores or voids and prevent reentry of air or other gas thereinto or the vacuum may be allowed to decrease to a greater or less degree as the saturant is introduced.

If the vacuum has not been released upon the completion of the entry of the saturant into the tank, it is released at the end of the soaking period, the cover removed, and the basket of saturated tubes or conduits taken out of the tank. The vacuum may be gradually released so that pressure gradually increases on the body of saturant forcing additional saturant into the fibrous tubes. They may then be allowed to drain for from 2 to 6 minutes or longer, cooled, and stored for shipment to the consumer. If desired, the conduits, prior to final draining, may be given a wash treatment with bituminous saturant at a temperature higher than that of the saturant to remove any foreign matter, such as lint, adhering to the saturated tube walls.

The pitch remaining in the tank **33** (Fig. 2) by opening valves **36** and **37** is permitted to return to kettle **31** disposed at a level below that of the base of tank **33** as shown in Fig. 2. If desired, the pitch remaining in the tank **33** may be drained to a tank or other point of disposal through pipe **38** by keeping valve **36** closed and opening valve **37** and the valve in pipe **38**. Vapor coming off from the saturant in the case of the apparatus of Fig. 1 is condensed in condenser **17** and the condensate collected in the oil and water collector **25**. Any oils coming off from the pitch may be separated from the water in the collector **25** and returned to the system. In the apparatus of Fig. 2, liquid collected in receiver **49** and safety tank **52** may be conserved.

In the drawings, I have shown tubes or conduits treated in a vertical position. By suitable changes in the apparatus, I may treat them equally effectively in a horizontal position.

In the table below there are given three examples of processes of saturating fibrous tubes, having about 1.6 cc. of voids per gram of tube wall and approximately 7 per cent moisture, in accordance with this invention.

Example number	I	II	III
Weight of unsaturated tube	1.740 kg.	1.790 kg.	1.785 kg.
Weight of saturated tube	5.730 kg.	5.750 kg.	5.450 kg.
Weight of pitch saturant absorbed by the tube.	3.990 kg.	3.960 kg.	3.665 kg.
Percentage saturation	229.3%	221.2%	205.6%.
Vacuum in inches of Hg maintained on saturating tank during initial drying period.	27 inches.	27 inches.	27 inches.
Duration of drying period	120 min.	45 min.	60 min.
Temperature of pitch in melting kettle.	320° F.	320° F.	320° F.
Time required for flow of pitch from storage tank or kettle to saturating tank after drying was completed.	15 min.	30 sec.	60 min.
Total time vacuum was exerted on fibrous conduits.	135 min.	45½ min.	120 min.
Time of soaking conduits in saturant.	120 min.	45 min.	60 min.
Temperature of saturant in which the conduits were soaked.	320° F.	320° F.	320° F.
Time of air draining the conduits.	2 min.	4 min.	6 min.

In each of the above examples 8 inches of pitch were placed in the bottom of the saturating tanks during the vacuum drying. The pitch was kept hot by steam heating the saturant, and the vapors coming over were condensed and collected.

Sections through the top, middle, and bottom of the saturated conduits of Example II were tested for waterproofness, i. e., were immersed in distilled water at a temperature of about 70° F. for 48 hours and the following results obtained:

Section	Top	Middle	Bottom
Weight after test	537.2 grams.	564.7 grams.	620.0 grams.
Weight before test	521.6 grams.	552.0 grams.	616.0 grams.
Weight of H_2O absorbed	15.6 grams.	12.7 grams.	4.0 grams.
Percentage absorption	3.05%	2.30%	0.65%.

It will be noted that the average percentage absorption of the three sections representing the percentage absorption of the conduit is 2 per cent.

I have found, as a result of work performed, that a conduit having about 1.6 cc. of voids per gram of tube wall saturated in accordance with my invention with coal tar pitch will absorb an amount of saturant equal to more than 200 per cent of the weight of the dry unsaturated base. In the case of Examples I and II above, it will be noted that the conduit absorbed approximately 225 per cent by weight of saturant. In saturating very dense fibrous conduits, for example, conduits having approximately 0.67 cc. of voids per gram of tube wall, with coal tar pitch or other bituminous saturant, the amount of saturant absorbed will be found to be at least 80 per cent by weight of the dry unsaturated base.

Instead of drying the conduits in the preferred manner by subjecting them to vacuum as hereinabove described, the conduits may be soaked in hot saturant, such as coal tar pitch or other bituminous waterproof saturant, until foaming of the pitch stops and substantially all moisture is removed from the conduit walls. The saturant is maintained at a temperature materially above the boiling point of water during the drying of the conduits, for example, at a temperature of about 300° F. If this procedure is followed, present equipment for saturating fibrous conduits involving the soaking of the conduits in the hot saturant may be employed to dry the conduit. After the conduits have been dried, they may be saturated under vacuum in accordance with this invention. The saturant employed may be the saturant in which the conduits were immersed to effect the drying or fresh waterproofing saturant may be utilized.

It will be noted that the process of this invention results in a more thorough saturation of the fibrous conduits than prior processes and requires materially less time for efficient saturation and impregnation of the fibrous conduits. The conduit of this invention has the voids or pores substantially completely filled with coal tar pitch or other saturant employed and has the coal tar pitch or other saturant covering the fibers and bonding with the pitch in the voids. Hence, the fibrous base is effectively waterproofed and protected against corrosion, abrasion, and soil pressures. In prior conduits, the voids are not completely filled with the saturant as in the conduit of this invention; prior conduits, therefore, are distinctly less waterproof than are the conduits of my invention. Further, in prior saturated fibrous conduits, probably due to the long time immersion of the bases in the hot saturant, the

organic bases are charred and burned with consequent impairment of the final products. The tendency for charring and burning of the organic bases of the conduits saturated in accordance with this invention is substantially eliminated since the time of contact between the organic bases and the saturant is materially reduced.

As the saturant for the practice of the preferred embodiment of this invention, coal tar pitch, preferably at a temperature of from 300 to 330° F., is employed; this results in a product of substantially improved character. The conduit of this invention, saturated with coal tar pitch, absorbs materially less moisture, is more resistant to corrosion, abrasion and soil pressures, and is of greater tensile and compressive strength than the saturated conduits heretofore known to me. It is also much more resistant to attack by molds, fungi, and all cellulose-destroying organisms. Further, conduits saturated with coal tar pitch have strikingly improved waterproofness. The conduits of the invention have been immersed for 48 hours in distilled water at a temperature of 77° F. and have absorbed substantially less than 4 per cent water, and as little as about 1 per cent water. As among coal tar pitches, I prefer to use those produced by a vacuum or other low temperature process, having a relatively low "free carbon" content, and undergoing relatively little volatilization loss under the conditions of my saturating process.

It is to be understood that this invention is not restricted to the present disclosure otherwise than defined by the appended claims.

I claim:

1. The process of saturating conduits having relatively rigid walls of substantial thickness and density and constituted of organic fibrous material with a bituminous saturant in heat liquefied condition and which saturant upon prolonger contact with the conduits at saturating temperatures would cause substantial thermal deterioration of the walls thereof, which comprises subjecting the conduits to heat and vacuum conditions to remove occluded gas therefrom, thereafter, while maintaining the conduits under vacuum, gradually immersing them in the bituminous saturant maintained in heat liquefied condition at an elevated temperature so that the saturant enters and fills the voids and entry of air into the voids is prevented, and then soaking the conduits in the saturant for a period of time insufficient to cause substantial thermal deterioration of the conduit walls but sufficient to impregnate the conduits so that when immersed in distilled water at 77° F. for 48 hours they will absorb less than 4 per cent water.

2. The process of saturating dense paper conduits having relatively rigid walls of substantial thickness with a bituminous saturant 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 heat and vacuum conditions to remove occluded gas therefrom, thereafter, while maintaining the conduits under vacuum, gradually immersing them in the bituminous saturant maintained in heat liquefied condition at an elevated temperature so that the saturant enters and fills the voids and entry of air into the voids is prevented, and then soaking the conduits in the saturants for a period of time insufficient to cause substantial thermal deterioration of the conduit walls but sufficient to impregnate the conduits so that when immersed in distilled water at 77° F. for 48 hours they will absorb less than 4 per cent water.

3. The process of saturating conduits having relatively rigid walls of substantial thickness and density and constituted of organic fibrous material with a coal tar pitch saturant containing free carbon, which comprises subjecting the conduits to heat and vacuum conditions out of contact with the saturant to remove occluded gas therefrom and thereafter, while maintaining the conduits under vacuum, gradually immersing them in the said coal tar pitch saturant, 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 and entry of air into the voids is prevented.

4. The process of saturating conduits having relatively rigid walls of substantial thickness and density and constituted of organic fibrous material with a coal tar pitch saturant containing free carbon, which comprises subjecting the conduits to heat and vacuum conditions out of contact with the saturant to remove occluded gas therefrom, thereafter, while maintaining the conduits under vacuum, gradually immersing them in the said coal tar pitch saturant 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 and entry of air into the voids is prevented and then soaking the conduits in the coal tar pitch saturant for not more than two hours.

5. 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 maintained in heat liquefied condition at an elevated temperature, which comprises immersing dry conduits in the saturant while maintaining vacuum conditions in the saturating zone so as to prevent the formation of an impenetrable layer of free carbon on the surface of the conduits and thereafter permitting the conduits to soak in the hot saturant for a period of time insufficient to cause substantal thermal deterioration of the fibrous base of the conduits but sufficient to substantially completely fill the voids in the walls of said conduits.

6. The process of saturating conduits having relatively rigid walls of substantial thickness and density and constituted of organic fibrous material with a bituminous saturant maintained in heat-liquefied condition at an elevated temperature 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 heat and vacuum conditions to remove occluded gas, immersing the conduits in the saturant, maintaining vacuum conditions in the saturating zone while the conduits are immersed in the saturant and permitting the conduits to soak in the hot saturant for a period of time insufficient to cause substantial thermal deterioration of the fibrous base of the conduits but sufficient to substantially completely fill the voids in the walls of said conduits so that when immersed in distilled water at 77° F. for forty-eight hours the conduits will absorb less than 4% water.

GEORGE EMBERG.

CERTIFICATE OF CORRECTION.

Patent No. 2,012,961. September 3, 1935.

GEORGE EMBERG.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, after line 68, insert the syllable and words duced in this manner having a melting point; and page 6, first column, line 40, claim 1, for "prolonger" read prolonged; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 8th day of October, A. D. 1935.

Leslie Frazer

(Seal) Acting Commissioner of Patents.