

Sept. 3, 1935.

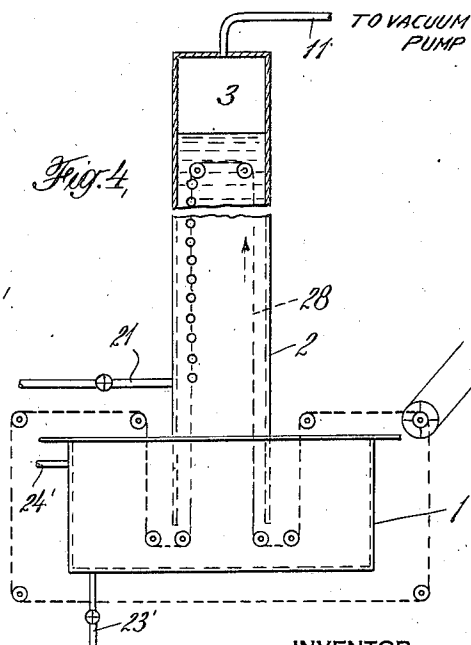
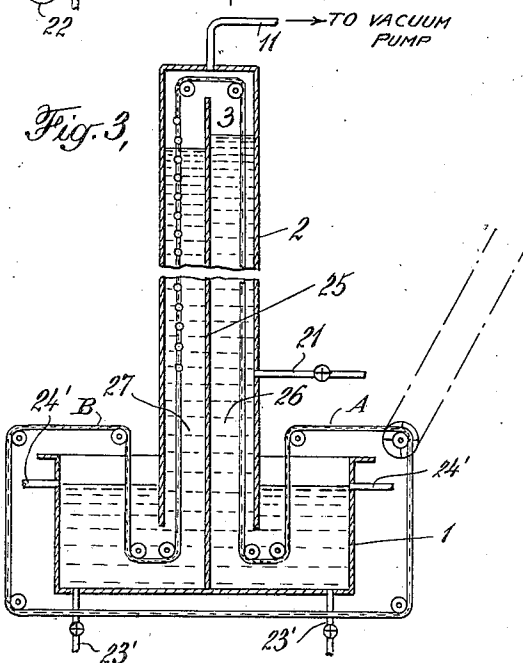
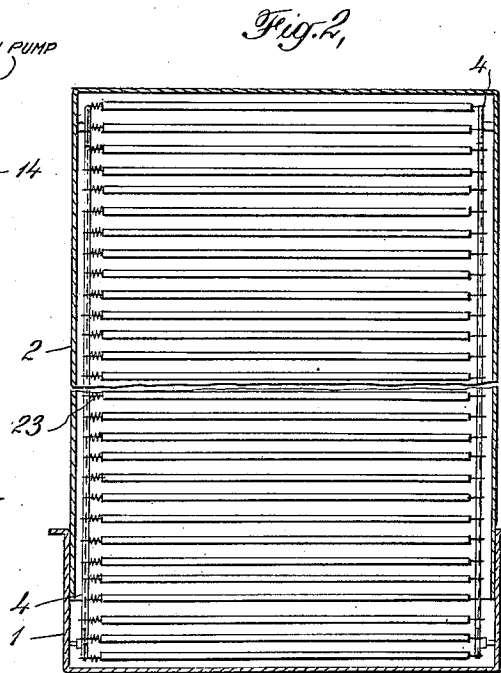
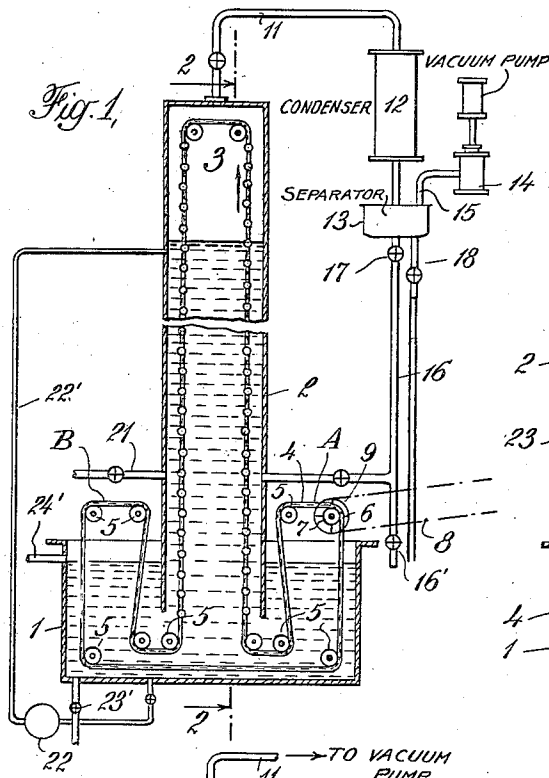
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2,012,969

CONTINUOUS SATURATION OF ABSORBENT ARTICLES SUCH AS FIBROUS CONDUITS

Filed June 29, 1932

7 Sheets-Sheet 1



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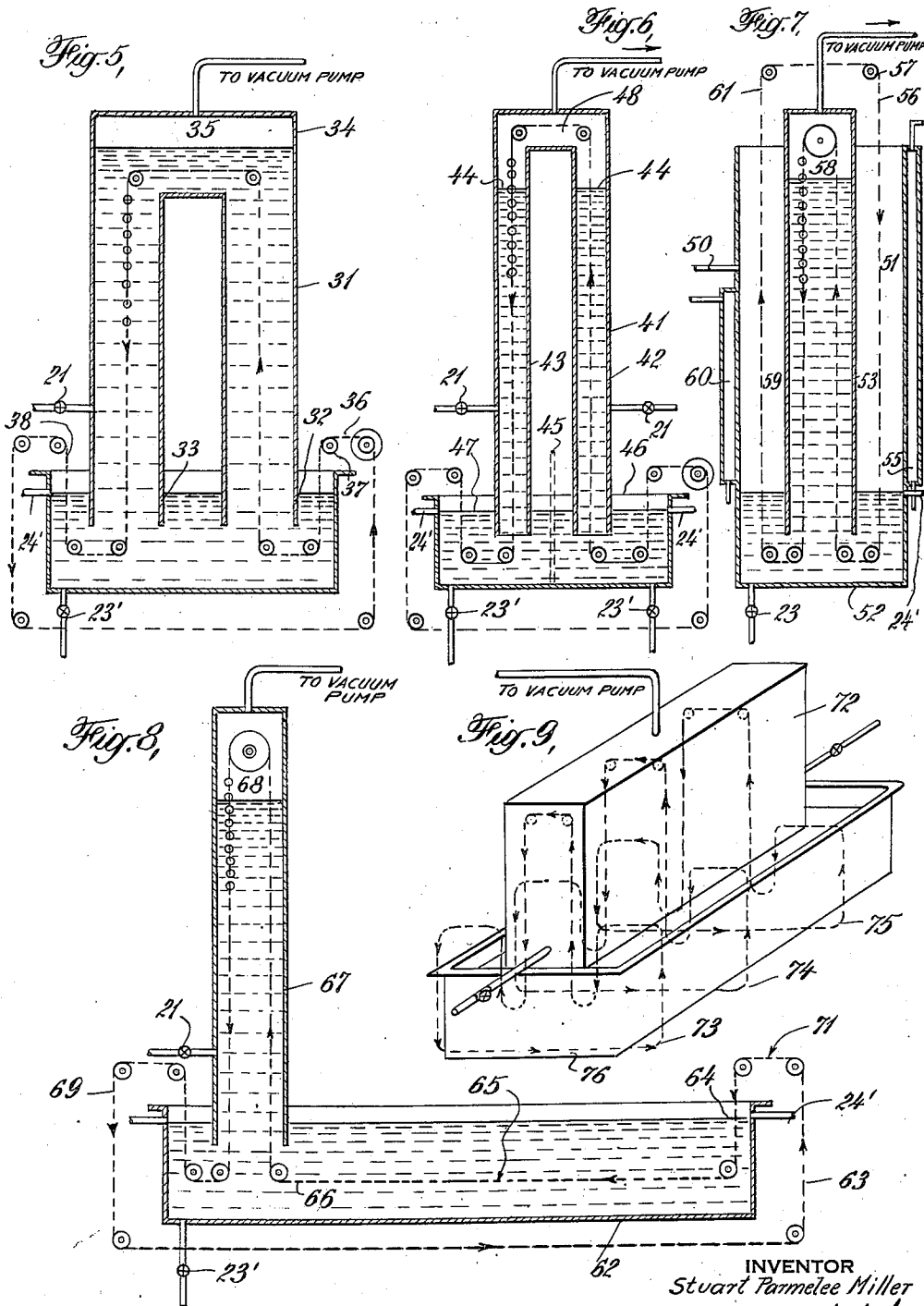
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CONTINUOUS SATURATION OF ABSORBENT ARTICLES SUCH AS FIBROUS CONDUITS

Filed June 29, 1932

7 Sheets-Sheet 2



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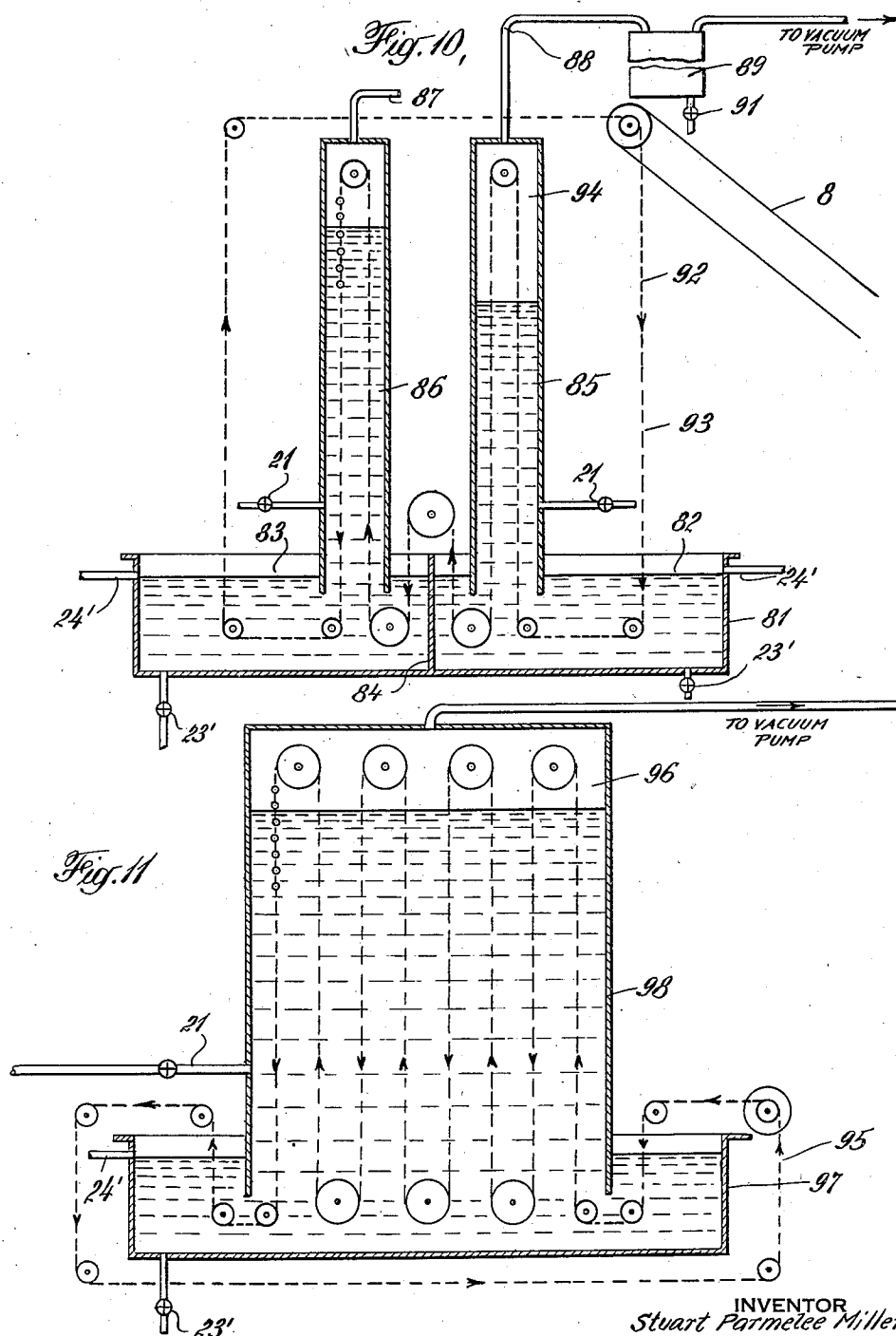
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CONTINUOUS SATURATION OF ABSORBENT ARTICLES SUCH AS FIBROUS CONDUITS

Filed June 29, 1932

7 Sheets-Sheet 3



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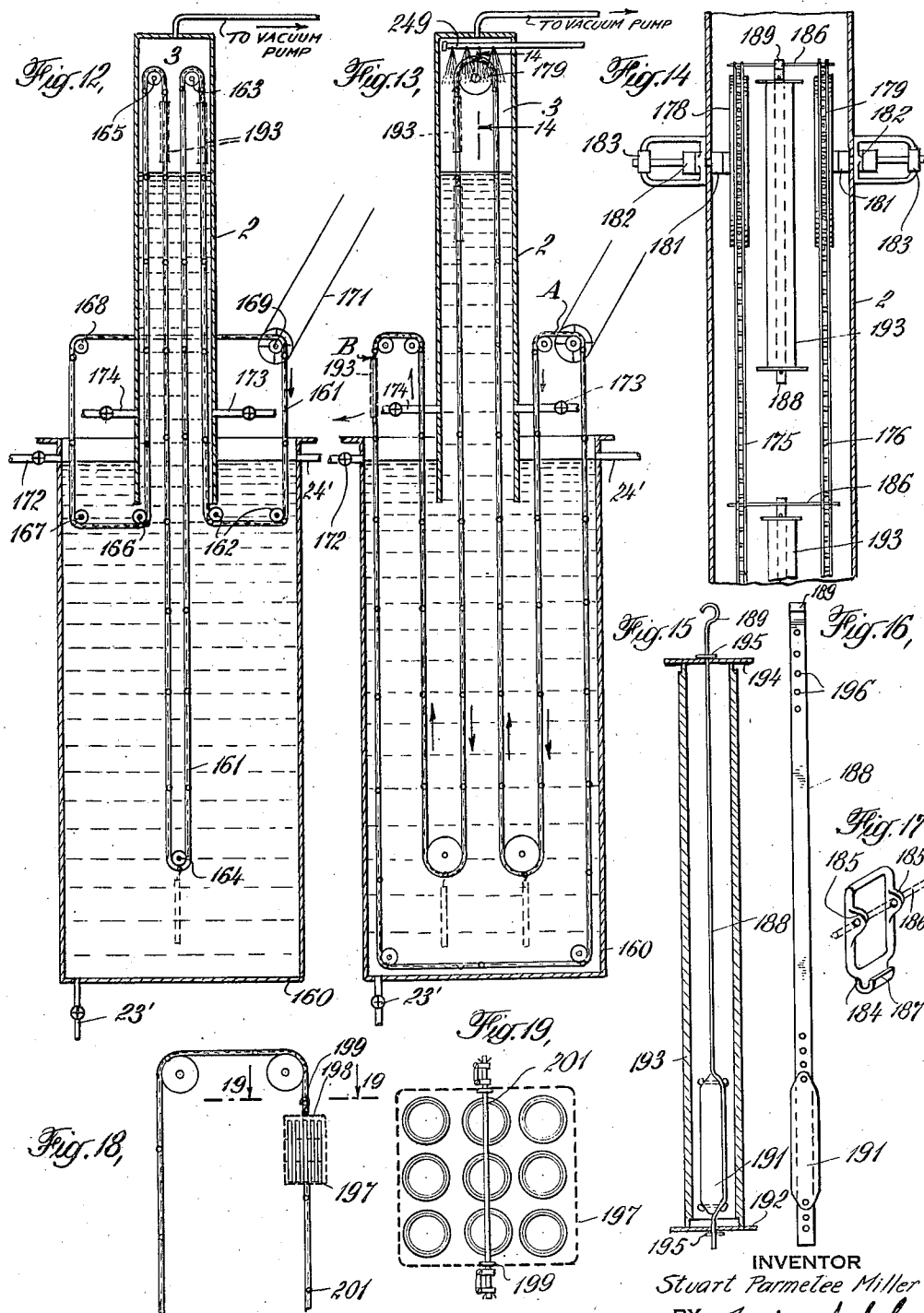
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CONTINUOUS SATURATION OF ABSORBENT ARTICLES SUCH AS FIBROUS CONDUITS

Filed June 29, 1932

7 Sheets-Sheet 4



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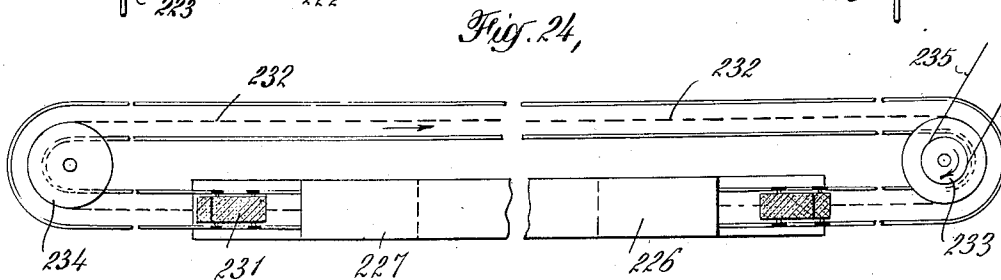
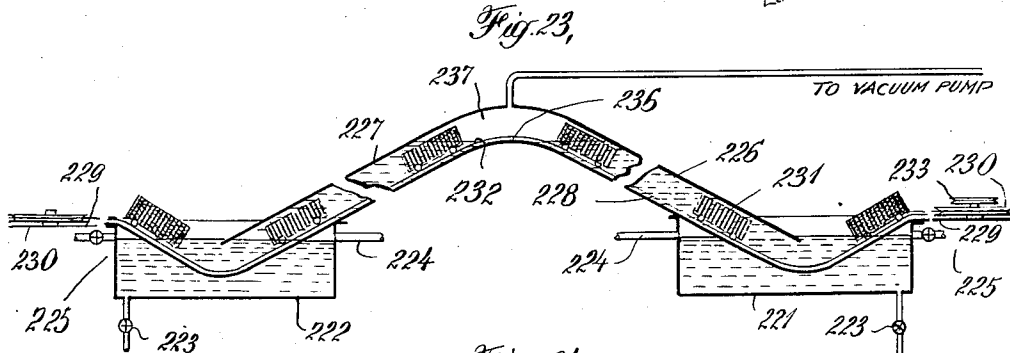
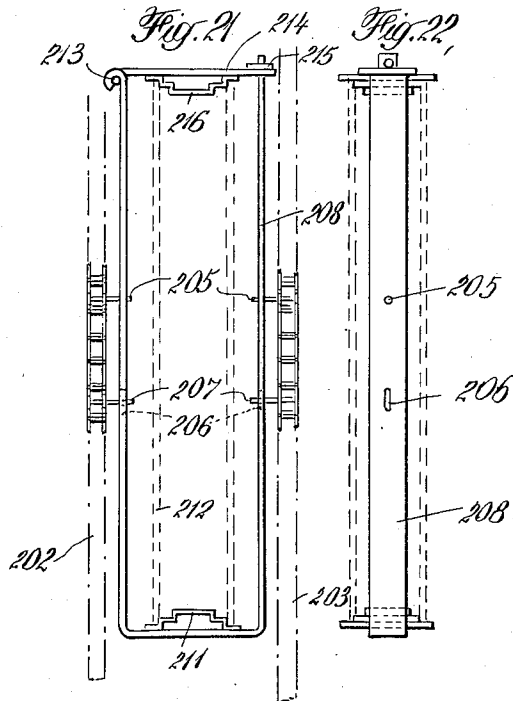
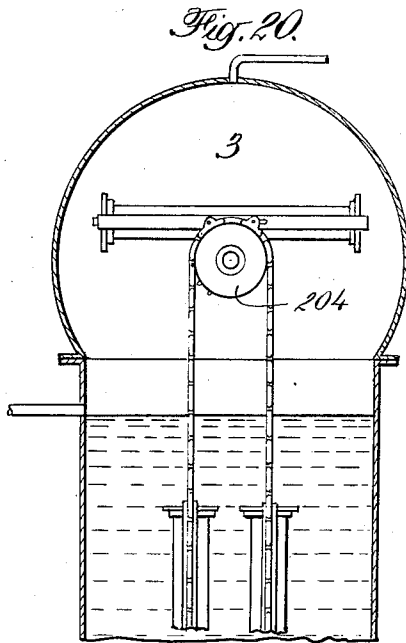
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CONTINUOUS SATURATION OF ABSORBENT ARTICLES SUCH AS FIBROUS CONDUITS

Filed June 29, 1932

7 Sheets-Sheet 5



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CONTINUOUS SATURATION OF ABSORBENT ARTICLES SUCH AS FIBROUS CONDUITS

Filed June 29, 1932

7 Sheets-Sheet 6

Fig. 25,

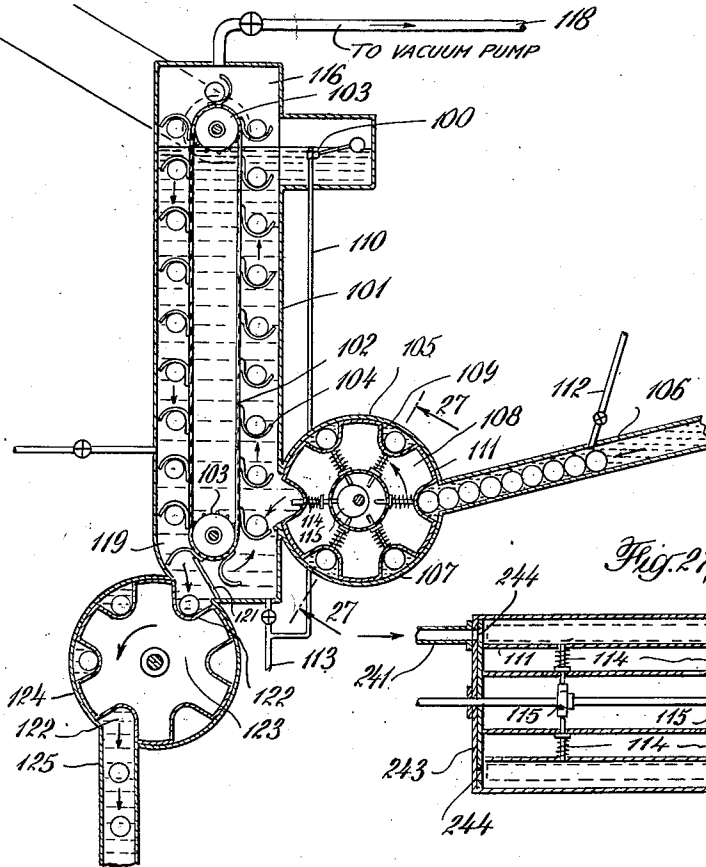


Fig. 27,

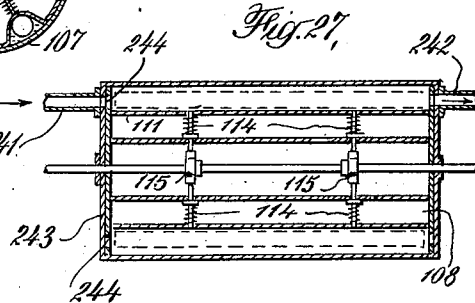
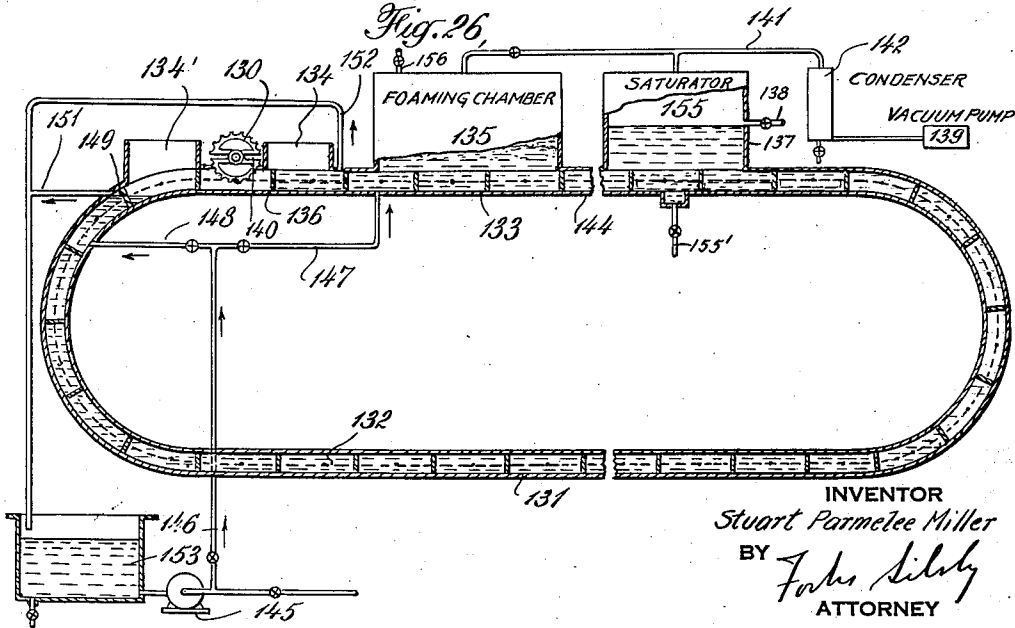


Fig. 26,



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CONTINUOUS SATURATION OF ABSORBENT ARTICLES SUCH AS FIBROUS CONDUITS

Filed June 29, 1932

7 Sheets-Sheet 7

Fig. 28,

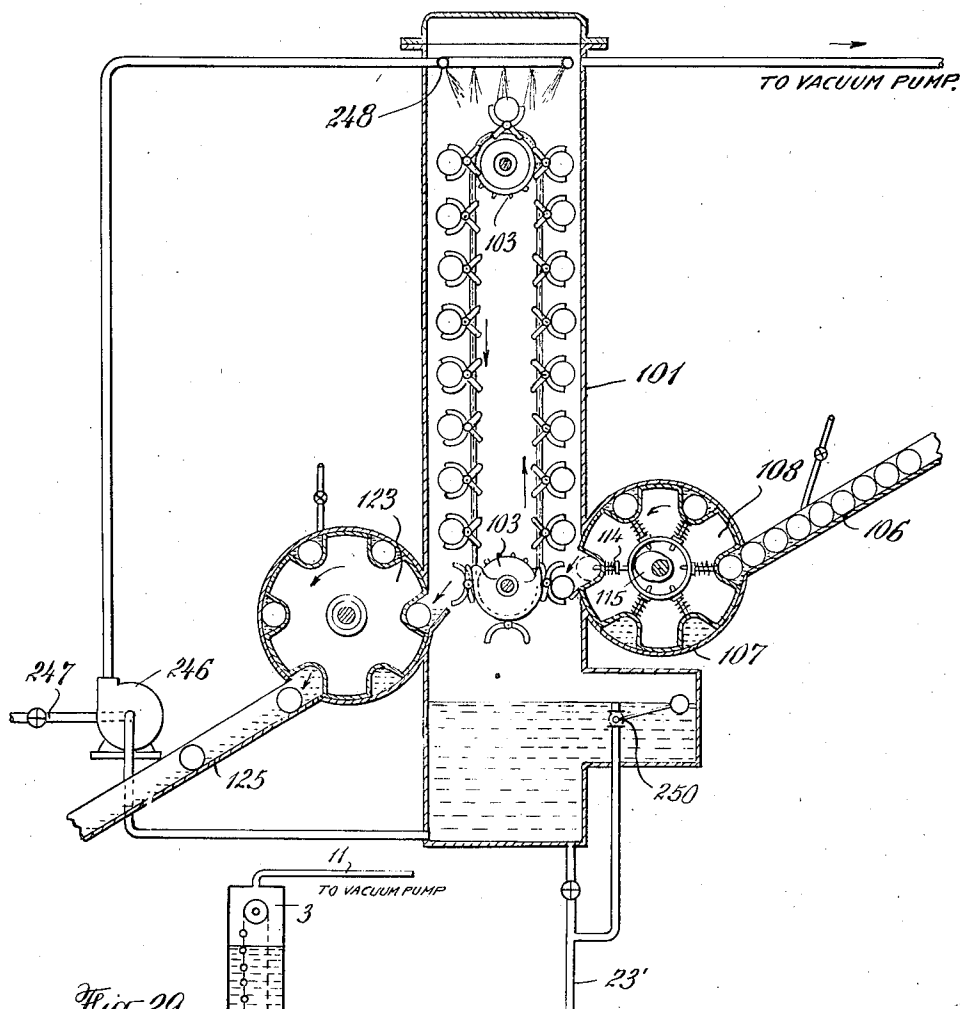
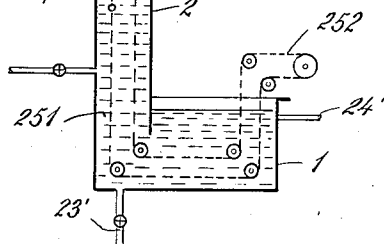


Fig. 29.



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UNITED STATES PATENT OFFICE

2,012,969

CONTINUOUS SATURATION OF ABSORBENT
ARTICLES SUCH AS FIBROUS CONDUITSStuart P. Miller, Englewood, N. J., assignor to The
Barrett Company, New York, N. Y., a corpora-
tion of New Jersey

Application June 29, 1932, Serial No. 619,939

7 Claims. (Cl. 91—70)

This invention is directed to the saturation of absorbent articles, and particularly, the continuous saturation and impregnation of fibrous conduits employed to conduct and protect under-
ground cables, telephone lines, electric light, and other conductors, and for the formation of water pipes, drain pipes to render them substantially waterproof and resistant to abrasion, corrosion, and conditions encountered above or 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, etc., asbestos articles, concrete pipes, flashing blocks, and to impregnate and saturate wood.

The article 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 or other shaped 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 2 inches to 6 inches or larger in internal diameter, have an average wall thickness of approximately $\frac{3}{8}$ 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 $\frac{3}{8}$ 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 de-

termine 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° F. 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) Loss of volatile oils due to prolonged heating in inadequately covered apparatus. Foaming of the pitch caused by the presence of water in the conduits being treated increases the loss of volatile oils;

(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;

(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; 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 and 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 satisfactorily 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 saturating porous or absorbent articles in a simple and continuous manner as distinguished, for example, from the batch procedure of saturation disclosed in my copending application Serial No. 613,939, filed May 27, 1932. The process of this invention is of high capacity, low in operating and equipment costs, capable of automatic regulation, requires a minimum of saturant for its practice, materially reduces saturation costs, and results in a uniformly saturated conduit of improved waterproofness and resistant to corrosion, abrasion, and soil pressures. The saturation of conduits in accordance with this invention requires relatively short time of contact between the saturant and fibrous bases. Hence, tendencies toward charring or burning the organic bases are substantially reduced. Further, the process of this invention is flexible and can readily be adapted to efficiently saturate articles vary-

ing widely in their porosity, e. g., dense or porous conduits, with different saturants.

In accordance with a preferred embodiment of the invention, the conduits individually or in groups placed in baskets or other holders, are moved continuously through a drying zone, then through a saturating bath maintained under vacuum, and thereafter through a draining zone. After passage through at least a portion of the bath and before final draining, the conduits may be subjected to vacuum while out of contact with the main body of saturant and then again passed through the saturating bath. While in contact with the saturant, the conduits may be subjected to increased pressures. The conduits are preferably withdrawn from the saturating bath at a rate equal to the feed of incoming dried conduits into the bath. The rate of feed of conduits through the drying and the saturating zones may be substantially the same so that conduits are continuously dried and saturated, the saturated conduits being removed at a rate corresponding to the rate of introduction of wet or partially dried conduits into the drying zone, and the rate of introduction of the dried conduits into the saturating zone.

The term "continuous" is used in the specification and claims in a broad sense and is intended to differentiate the process of this invention from batch processes involving the drying of conduits in suitable apparatus, followed by the saturation of the dried conduits, the apparatus throughout the period required for drying and saturation being employed to dry and saturate one and the same batch of conduits. By the term "continuous" as used herein, it is intended to include the passage of conduits or other articles to be saturated intermittently, i. e., step-by-step, through the drying and/or saturation zones, the material remaining at rest for predetermined periods of time in its passage therethrough, as well as the non-stop passage of the material through the drying and/or saturation zones.

In one form of my invention, a barometric column of saturant is provided in a tank open at the lower end and closed at the upper. The open end of the tank is placed below the level of saturant in the container and thus is liquid sealed. The vacuum created in the tank may be employed to cause the saturant to rise to its barometric level. A low, medium, or high vacuum (the high vacuum corresponding to a vacuum of 28 to 29 inches of mercury) may be maintained in the upper portion of the saturating tank. The higher the vacuum maintained, the more effective is the removal of air and water from the voids and the more complete is the absorption of saturant. The tank is preferably made of such height that a considerable evacuated space is provided above the maximum level of saturant.

A conveyor carrying baskets or other holders may be loaded with tubes or conduits. The baskets enter the pitch or other saturant, travel down through the pitch under the sealing edge of the saturating tank, and then pass upwardly through the saturant. The conduits on entering the hot saturant give up part of their contained air and water. As they rise in the barometric column of saturant, more and more of the air and water will escape as the pressure on the conduit walls decreases, due to the decreasing head of pitch thereon. Pitch or other saturant will flow into the voids in the conduit walls. The conduits leave the upper surface of the pitch and are then exposed to the vacuum in the evacuated space

above the pitch. This results in the withdrawal of residual air and moisture in the conduit walls. The conduits then reenter the pitch or other saturant, passing downwardly therethrough, the saturant entering the voids evacuated as a result of exposure of the conduits to the maximum vacuum maintained in the top portion of the saturating tank. Thereafter, the conduits are passed under the sealed edge of the saturating tank and withdrawn, drained, and cooled. The time required for the passage of the conduits through the cycle briefly described above can be varied by regulating the speed of the conveyor carrying the conduits or adjusting the depth of the saturant through which the conduits are passed or by operating the conveyor as a periodically interrupted mechanism.

During the final downward passage of the conduits through the column of saturant, increase of the pressure head of the pitch as the conduit passes downwardly forces additional amounts of saturant into the vapor- and air-free voids effecting substantially complete saturation. Slow change of pressure head of pitch on the conduit walls during both the upward and downward passage through the barometric column of saturant has the advantage of permitting satisfactory saturation with saturants containing fine suspended or colloidal 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 fibrous conduit and the avoidance of such impenetrable layers, insures greater penetration and improved saturation. The withdrawal of the conduits from the saturant into the vacuum space above the saturant not only is effective in withdrawing residual gases and water vapor from the conduit voids but is also effective in loosening and in part removing any, more or less, impenetrable layers of free carbon or similar material which may have accumulated on the conduit surfaces during the upward passage through the saturant. On the subsequent downward passage, the saturant readily passes through the loosened layers of free carbon and fills the exhausted pores or voids.

The conduits may be initially dried by passage through a chamber maintained under vacuum, the dried conduits being delivered to the conveyor, passing through the saturating bath. As an alternative procedure of drying the conduits, they may be soaked in hot saturant at atmospheric or super-atmospheric pressure or under vacuum. In the case of the soaking of fibrous conduits in bituminous material such as coal tar or water gas tar pitch, the soaking is continued until foaming of the pitch stops and substantially all moisture is removed from the conduit walls. During the drying of the conduits the pitch is maintained at a temperature materially above the boiling point of water; for example, at a temperature of about 300° F. if atmospheric pressure is employed. If this procedure of drying the conduits is followed, the container for the saturant may be elongated so that the conveyor carrying the conduits first passes through an elongated bath of saturant, thus drying the conduits and from this bath of saturant, the conveyor carries the conduits continuously into the base of the barometric column of saturant, up there-through into the evacuated space thereabove, down through the column of saturant and out of the container, permitting their removal from the

conveyor. A partition may be placed in the container separating the drying zone from the saturating zone so that different saturant material may be employed for effecting the drying from that utilized to saturant the material.

The conduits may be dried by first passing them through a heated zone out of contact with the saturant. The conveyor passing through the column of saturant may be disposed so as to feed the conduits first through the heating zone, then into the saturant, the conduits thus being continuously dried and saturated.

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 absorbent material can be accomplished as herein described, thereby facilitating the wetting and impregnation and/or saturation of the porous articles by the saturant.

As the saturant for the conduits, coal tar pitch, water gas tar pitch, asphalt, cutback pitches, blended pitches, or other waterproofing material may be used. A coal tar pitch having a melting point of from 140 to 180° F. is particularly suitable for saturation of 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 articles 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 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 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 158° F. melting point when tested (cube in water) 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 when tested (cube in air) 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 flash 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 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 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.

After final saturation, the conduits are drained. Heretofore, they have been drained in vertical position so that frequently the surface of the lower end contained more saturant than the surface of the upper end. To avoid this objection, in accordance with my invention, the conduits may be rotated about their longitudinal axes while still hot so that drainage longitudinally of the axis of the conduits is retarded and due to centrifugal force exerted on the conduit, the pitch is maintained in position on the conduit walls while setting. Rotation of the conduits has a tendency to cause concentration of the saturant at the outer periphery, leaving the inner walls relatively unsaturated. To obtain a uniformly saturated product, hot pitch or other saturant may be added to the inner walls of the tubes during the initial rotation. In lieu of this procedure, the conduits may be rotated slowly while still hot and at the same time alternately elevated at the opposite ends thereof. If desired, the tubes may be partially drained in vertical position, then inverted and the draining completed while in inverted position. By regulating the rate of temperature drop in the draining zone and the rate of cooling, a uniformly saturated conduit will be obtained. Still another form of draining is to squeeze the tube walls as they leave the saturating bath and then chill rapidly, preferably while rotating the tubes.

As a modification of the procedure hereinabove described, instead of maintaining a barometric column of saturant, a column of saturant of any desired height may be provided in a tank that is mechanically sealed so that a column of any desired height may be maintained under vacuum thereon. The tank may be relatively small and not of a height necessary to accommodate a

barometric level. Dried conduits may be continuously fed to the tank while pitch is circulated under pressure therethrough and the conduits thus effectively saturated as more fully pointed out hereinafter.

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 such as conduits, this invention may be employed in fire-proofing, oil proofing, gas proofing, insulating, painting and coloring such articles. For example, in fireproofing an article, it may be impregnated with an aqueous solution of inorganic salts, e. g., solutions comprising inorganic phosphates, in oil proofing a resin or cellulose solution may be used, in gas proofing and insulating the articles may be saturated with resin, cellulose or rubber mixture and in painting and coloring the articles 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.

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 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, in which like reference numerals designate like parts,—

Fig. 1 is a vertical section, partly in elevation, through a saturating tank for practicing the process of this invention;

Fig. 2 is a vertical sectional view taken on the line 2—2 of Fig. 1, showing the conveyor for carrying individual conduits in horizontal position through a barometric column of saturant;

Fig. 3 is a vertical section through a modified form of apparatus for practicing the invention; the saturating apparatus of this figure involves a partition dividing it into two sections;

Fig. 4 shows a further modified form of ap-

paratus for practicing the invention. In the modification of this figure, the conveyor for carrying the conduits through the column of saturant does not pass into the evacuated space thereabove;

Fig. 5 shows a further modified form of apparatus for practicing the invention involving a U-shaped column of saturant maintained under vacuum through which the conduits are passed;

Fig. 6 shows a modified form of saturating bath in which different types of saturant may be employed during the saturation operation;

Fig. 7 shows an arrangement of apparatus for practicing the process of this invention involving a heating zone contiguous to the entrance of the conduits into the saturating bath and a draining compartment contiguous to the point of exit of the conduits from the saturating bath;

Fig. 8 shows an arrangement of apparatus for practicing this invention involving an elongated container for the saturant through which the conduits may be passed and thus dried;

Fig. 9 shows an arrangement of saturating apparatus for practicing the process of this invention involving a plurality of conveyors for carrying articles through the saturating bath;

Fig. 10 shows an arrangement of apparatus for practicing the process of this invention involving two separate columns of saturant, each maintained under vacuum;

Fig. 11 shows apparatus for practicing the process of this invention involving a multiple pass of the conveyor carrying the articles to be saturated through the saturating bath maintained under vacuum;

Fig. 12 shows a further modified form of apparatus involving a deep body of saturant through which the conduits may be passed and subjected to substantial pressure heads of saturant;

Fig. 13 shows a further modified form of apparatus involving a deep body of saturant through which the conduits may be passed and depicts individual holders for the conduits, maintaining them in a vertically suspended position throughout the travel of the conduit through the saturant;

Fig. 14 is a fragmentary vertical section taken on the line 14—14 of Fig. 13, partly in elevation, on an enlarged scale as compared with Fig. 13, and shows the mounting for the sprockets over which the conveyor chains pass;

Fig. 15 shows an elevation of one of the conduit holders, the conduit being shown in vertical section;

Fig. 16 is a front elevation of the conduit holder;

Fig. 17 is a perspective view of a link of the conveyor chain, the link shown carrying a pin from which a conduit holder may be suspended;

Fig. 18 is a fragmentary view somewhat diagrammatic in character, showing the suspension of a basket of conduits from a conveyor chain;

Fig. 19 is a plan view of one of the baskets containing conduits taken in a plane passing through line 19—19 of Fig. 18;

Fig. 20 is a fragmentary vertical section through the top portion of the saturating tank, parts being shown in elevation, and shows apparatus for saturating conduits in which the conduits are reversed during their travel through the space above the column of saturant;

Fig. 21 is a fragmentary elevation of a view of the conveyor chain and one of the conduits carried thereby mounted for reversal as in the case of Fig. 20;

Fig. 22 is a front elevational view of the strap holder of Fig. 21, the conduit being shown in section;

Fig. 23 is a side elevation of a modified form of apparatus for practicing this invention. This apparatus is particularly designed for the handling and saturation of large numbers of conduits;

Fig. 24 is a plan view of the apparatus of Fig. 23;

Fig. 25 shows a vertical section through a mechanically sealed type apparatus for saturating conduits in accordance with the process of this invention; i. e., the saturating tank of Fig. 25 is sealed at its base so that any desired height of saturant may be maintained therein;

Fig. 26 shows a modified form of mechanically sealed type apparatus for saturating conduits;

Fig. 27 is a vertical section, parts being shown in elevation, taken in a plane passing through line 27—27 of Fig. 25;

Fig. 28 is a vertical section through a mechanically sealed type apparatus for saturating conduits in which the saturant is sprayed onto the conduits; and

Fig. 29 is a diagrammatic view of a further modified form of apparatus for practicing the invention. In the apparatus of this figure the conduit load and discharge stations occur on the same side of the container and not on opposite sides as in the case of the apparatus of Fig. 1.

In the drawings, Fig. 1, reference numeral 1 indicates a container of sufficient capacity to hold the saturant required in the saturating process. Disposed within the container is a tank 2 of a height sufficient to accommodate a barometric column of saturant and leave a space 3 of substantial extent in the top of tank 2. The base of tank 2 is open and extends below the level of saturant in container 1 so that a liquid seal is provided at the base of the saturating tank. A conveyor chain or belt 4 passes about guide sprockets or pulleys 5 suitably mounted. Pulley 6, over which the chain or belt 4 passes, is mounted on a driven shaft 7. Shaft 7 may be driven by means of belt 8 passing over pulley 9 fixed to shaft 7 or through other suitable driving mechanism.

A valve-controlled pipe 11 leads from the top of saturating tank 2 through a condenser 12 into a separator 13. Condenser 12 condenses any oil vapors coming off from the saturant and reduces the volume of gas and water vapor handled by vacuum pump 14 communicating through pipe 15 with the trap 13. A pipe 16 connects the separator 13 with the saturating tank 2 to return, if desired, distillate oil in the separator 13 to the tank 2. Valve 17 in pipe 16 controls flow there-through. A valve-controlled pipe 18, of a length sufficient to accommodate a barometric column of water, leads from separator 13 permitting disposal of the water content of the separator 13 to a suitable point. Valve-controlled pipe 18' communicates with pipe 16 for withdrawing oil from the separator 13 when it is not desired to return it to the tank 2. Fresh saturant is added continuously to replace the saturant absorbed by the conduits so that the volume of saturant within the system is maintained substantially constant. The amount of saturant fed to the tank must be such that the level of saturant in container 1 is maintained at a height above the base of tank 2 so that the liquid seal at the base of the tank is not broken. Pump 22 in line 22' connecting container 1 with tank 2 may be employed to circulate the pitch within the system and thus

maintain it of substantially uniform viscosity and free carbon content throughout the tank 1 and container 2. Tank 1 may be provided with a valve controlled drawoff 23' and an overflow pipe 24' communicating with a storage tank (not shown).

Fig. 2 shows a front elevation of the conveyor chains carrying individual fibrous conduits through the saturant. Chains 4 are disposed on opposite sides of tank 2 and are provided in this example with spring pressed pins 23 extending within the conduits and supporting the same.

Tanks 1 and 2 may be equipped with suitable heating elements, such as steam jackets or coils, regulators of well known type for maintaining and controlling the temperature and vacuum. The apparatus may be suitably heat insulated to reduce heat losses. For the sake of clearness, insulation, heating elements, and regulators have been omitted from the drawings.

Instead of affixing individual conduits to the conveyor chains, the latter may be provided with baskets or holders arranged to support the tubes or conduits in vertical, horizontal or other position. If it is desired to maintain the conduits in vertical position without reversal, the baskets may be suspended from the conveyor so that the conduits are maintained upright in both the up and down passage through the column of saturant, as hereinafter more fully pointed out. As an alternative, the baskets may be mounted on the conveyor so that when the direction of travel of the basket changes from upward to downward through the saturant, the basket is turned 180°, the top of the tubes during upward travel becoming the base of the tubes during the downward passage. Operation in the latter manner insures uniform saturation of the tubes from end to end. The baskets may be fixed to the conveyor or detachably secured thereon. In the former case, the conduits or tubes may be inserted in the baskets prior to the passage thereof into the saturant. For this purpose, the conveyor may be momentarily stopped or the conveyor may be caused to pass through an extended path prior to its passage into the saturant during which the conduits may be inserted in the basket. If the baskets are detachably secured to the conveyor, one basket containing saturated tubes may be removed at one point in the system while a basket containing unsaturated tubes secured to the conveyor at another point in the system, the conveyor being, if desired, momentarily stopped to permit the removal of the baskets from and attachment to the conveyor, or the baskets may be detached from and attached to the moving conveyor. For this purpose automatic pick up and drop mechanism for conveyor baskets of any well-known type may be employed. The baskets may be formed with projections or other members for spacing the tubes so that the tubes do not touch one another, thus insuring improved saturation. Also quick-opening basket doors may be provided permitting prompt loading and discharging of the conduits into and from the baskets. The conveyor may be of any suitable type, e. g., chain, cable, belt, apron, etc.

In the operation of the apparatus of Fig. 1, the pitch is maintained in the saturating tank in fluid condition. Saturating fibrous conduits having approximately 1.6 cc. of voids per gram of tube wall with coal tar pitch of specific gravity of 1.2 and a melting point of about 160° F., the pitch may be maintained at a temperature of about 320° F. while a vacuum of from 27 to 29 inches of

mercury is maintained in the evacuated space above the surface of the column of pitch. The height of the tank 2 above the atmospheric pitch level in 1 with such pitch should be approximately 38 feet providing for an evacuated space of approximately 10 feet above the maximum barometric column of pitch. To accommodate variations in atmospheric conditions, different specific gravity pitches, etc., a minimum clearance of 2 feet should be provided.

The basket or holder containing tubes or individual tubes, as shown in Fig. 2 may be affixed to the conveyor at a point to the right of tank 2, indicated by the reference numeral A (Fig. 1). The tubes will travel downwardly through the pitch under the sealing edge of the tank and will then gradually move upwardly through the column of saturant. Hence, the tubes are at first subjected to saturant at atmospheric pressure then to saturant at somewhat above atmospheric pressure and then gradually rise in the column, the head of saturant on the conduit walls being gradually reduced. Consequently, as the tubes pass through the initial stages of the saturating process more and more moisture and gas are removed from the tube walls and more and more pitch flows into the voids in the walls. Finally, the tubes leave the pitch and are subjected to the vacuum in space 3. This effects withdrawal of maximum amounts of residual air and water possible under equilibrium conditions existing in the evacuated space which, it will be noted, are favorable to substantially complete removal of air and other gas and vapor from the tube walls. Deposits of free carbon, etc., will also be loosened and in part removed in space 3. Thereafter, the tubes reenter the saturant and move downwardly therethrough, being subjected to gradually increasing pressure heads of pitch as they move downwardly. Upon reentry of the tubes into the pitch, the voids evacuated as a result of exposure to vacuum in space 3 are filled. The gradual pressure increase on the conduit walls due to downward movement through the column of saturant results in maximum amounts of saturant entering the conduits.

From the bottom of the column of saturant, conveyor 4 carries the tubes out of the saturating bath as indicated by the reference character B (Fig. 1). The saturated conduits may here be removed from the conveyor for draining and cooling.

The apparatus of Fig. 3 differs from that of Fig. 1 chiefly in that a partition 25 extends up from the base of container 1, into tank 2 to a point above the level of saturant and somewhat below the top of tank 2 dividing the tank 2 and container 1 into two compartments, 26 and 27. Pitch or other saturant of one characteristic, i. e., temperature, melting point, or type of saturant may be introduced into compartment 26 and saturant of a different characteristic placed in compartment 27. For example, a low melting point, relatively high penetrability pitch may be placed in compartment 26 to insure maximum penetration and a higher melting point pitch placed in compartment 27 to provide a seal coat about the conduit. In draining such seal coat will be left on the surface of the product since the high melting point pitch will not drain off as completely as the low melting point pitches. The temperature of the saturant may be maintained at any desired point and the temperature at the base of tank 2 may be lower or higher than that at the top of the tank.

In Fig. 4 is shown apparatus for saturating fibrous conduits or other absorbent material in which a conveyor 28, shown somewhat diagrammatically, is so disposed that it does not carry the conduits into the evacuated space 3 above the level of saturant but maintains the tubes or conduits immersed throughout their passage through the barometric leg of saturant in tank 2.

Where it is desired to maintain in the saturating zone minimum amounts of saturant, apparatus such as shown in Figs. 5 and 6 may be employed. In Fig. 5 a U-shaped tank 31 is suitably supported with the open legs of the tank 32, 33, disposed within the saturant in container 1. Thus a liquid seal is maintained about the legs 32, 33 in tank 31. The tank is of a height such that a maximum barometric column of saturant may rise into the legs of the tank and partially fill portion 34 connecting the legs leaving a space 35 above the level of saturant. A conveyor 36 passing over suitable guide pulleys or sprockets 37 travels up through leg 31, through portion 34, down through leg 33, leaving the tank at 38. As in the case of the apparatus of Fig. 4, the material to be saturated throughout its passage through the saturant is shown as being maintained immersed and is not moved into the evacuated space above the level of the saturant. By enlarging space 35, provision may be made for allowing the conduits to leave the saturant and enter the vacuum space above.

In the apparatus of Fig. 6, a U-shaped tank 41, corresponding to tank 31 but of somewhat greater height, is utilized. Tank 41 is of such height that when vacuum is created therein maximum barometric columns of saturant rise in the legs 42, 43 thereof, the level of saturant indicated by the line 44 being below the top of legs 42, 43 of the tank. A partition 45 may, if desired, be disposed in container 1 to divide it into two portions 46, 47, which may, if desired, contain saturants of different characteristics. In the apparatus of Fig. 6, the conveyor carries the material to be saturated first through the saturant in leg 42, then into the U-shaped evacuated space 48, and then downwardly through the saturant in leg 43.

The apparatus of Fig. 7 involves a heating zone 51 positioned above the pitch in container 52. This container is made of sufficient capacity to hold the entire amount of saturant required in the practice of the process; that is to say, if for any reason the vacuum in tank 53 should break, the saturant will flow into and be retained in container 52. The heating zone 51 may be heated, e. g., by steam jacket or other heating chamber 55 surrounding a portion of vertical wall of container 52 above the level of saturant therein, or other heating means, e. g., steam pipes, may be used. The conduits or tubes may be affixed to conveyor 56 at the top thereof as indicated by reference numeral 57, then carried by the conveyor through the heating and drying zone 51 into the saturant in container 52, under the seal formed by base portion of tank 53 disposed below the level of saturant in container 52, thence up into the barometric leg of saturant into the evacuated space 58, down through the barometric leg of saturant and finally up through the draining zone 59. The draining zone 59 may be suitably heated as for example by steam jacket 60 and/or cooled as for example, by the passage of air or inert gas therethrough. Pipe 50 communicating with the upper portion of zone 59 may be employed to introduce cool air or other gas there-

into. The conduits may be removed from the conveyor at 61.

Instead of drying the conduits by passing them through a heating zone out of contact with the saturant they may be dried by immersion in hot saturant prior to passage up through the barometric leg of saturant maintained in the saturating tank. Apparatus such as shown in Fig. 8 may be employed for drying the conduits by passage through a bath of saturant. In this figure, reference numeral 62 designates an elongated container or kettle for the saturant. Container 62 may be covered or provided with means for removing fumes. Conveyor 63 is disposed to immerse the conduits carried thereby at 64 and to carry them while immersed through the extended path 65. Upon leaving the path 65 at 66, the dried conduits pass up through the barometric leg of saturant in tank 67 into the evacuated space 68 above the level of saturant therein, then down through the barometric leg of saturant, the saturated conduits being removed from the conveyor at 69. The wet conduits may be placed on a conveyor manually or automatically at a point indicated by reference numeral 71. Batches of conduits may be immersed in the saturant and thus dried and the dried conduits continuously passed through the barometric leg of saturant and thoroughly impregnated. That is to say, the drying may be batchwise followed by the continuous saturation of the dried conduits.

In the modifications hereinabove described, each saturating tank is provided with but one conveyor passing therethrough. Fig. 9 shows, somewhat diagrammatically, an arrangement of saturating tank and container for saturant involving the passage of three conveyors through the saturant in tank 72. This tank may, of course, be made of any desired size to accommodate any number of conveyors. Tank 72, it will be noted from Fig. 9, is relatively long and narrow. At spaced points along the length of the tank, conveyors 73, 74, and 75 are disposed and are arranged in parallel. Each conveyor passes, as indicated by the arrows, into the saturant maintained in tank 76 under the seal created by extension of the base of tank 72 below the level of saturant maintained in container 76 up through the barometric leg of saturant, into the evacuated space thereabove, down through the leg of saturant and finally out of the container at the side opposite to its entry into the container. The conveyors may be disposed so that they maintain the conduits carried thereby continuously immersed in saturant during their passage through the barometric leg of saturant as disclosed in Fig. 4, showing a saturating tank having a single conveyor passing therethrough.

For the saturation of conduits containing excessive amounts of moisture, apparatus such as shown in Fig. 10 is advantageously employed. The saturating tank of this figure is relatively long and is divided into two compartments, 82 and 83, by a partition 84. Two saturating tanks, 85 and 86, are disposed in compartments 82 and 83, respectively, with their inverted ends positioned beneath the level of saturant in container 81. The tops of both tanks 85 and 86 communicate with separate vacuum pumps (not shown) through lines 87, 88, respectively. If it is desired to maintain the same vacuum in both tanks lines 87 and 88 may communicate with one and the same vacuum pump. A foam catcher 89, provided with a valve-controlled draw-off 91, is disposed in line 88, leading from tank 85 to the vacuum pump. The conduits affixed to conveyor 75

92, passing through the apparatus as indicated somewhat diagrammatically in Fig. 9, at a point designated by reference numeral 93, are carried first up through the column of saturant in tank 85 into the evacuated space 94 above the level of saturant. Foam caused by the water content of the conduits is drawn off through line 88 and collected in tank 89. After passage through the column of saturant in tank 85, the conduits are passed into the saturant in compartment 83, up through the barometric leg of saturant in tank 86, and completely saturated as hereinabove described in connection with the apparatus of Fig. 1. Tank 85 may be made higher than tank 86 so that the conduits are carried through the vacuum space 94 for a considerable period, hence, completely evacuating the pores and voids. A relatively low vacuum may be maintained in tank 85 when excessively wet conduits are treated, thus avoiding undue foaming. If the vacuums maintained in tanks 85 and 86 are different the level of liquid therein will be different as shown in the drawings. The saturant placed in compartment 82 and tank 85 may be different from that employed in compartment 83 and tank 86.

In saturating dense fibrous tubes, for example tubes having less than 1 cc. of voids per gram of tube wall, apparatus such as shown in Fig. 11 may advantageously be utilized. In the apparatus of this figure, a conveyor 95 makes several passes up through the saturant into the evacuated space 96 thereabove and then again down through the saturant. The conveyor in the tank may be so arranged that it does not pass into the evacuated space 96, as shown in Fig. 11, but maintains the conduits immersed throughout their passage through the barometric leg of saturant as in the case of the apparatus of Figs. 4 and 5. In the case of the apparatus of Fig. 11, the conduits while immersed in the saturant at the base of the column are subjected to a pressure somewhat above atmospheric pressure, and when near the top of the saturant, are subjected to high vacuum. When removed from the pitch into the evacuated space 96, they are subjected to high vacuum out of contact with the saturant. The combination of long time immersion and the pulsation of saturant into and out of the side walls as the conduits progress through the cycle will yield tubes thoroughly saturated with pitch or other saturant uniformly distributed throughout the walls. It will be understood that the number of passes of the conveyor through container 97 and tank 98 of Fig. 11 may be whatever desired.

A second container (not shown) may be placed contiguous to the containers for saturant depicted in the various figures of the drawings and the conveyors arranged to pass through the second container. This second container may contain saturant at a temperature higher than that in the first container. As the saturated conduits are passed through the saturant in the second container they are washed free of lint, carbon, or other impurities.

A drainage conduit or passage such as 59 of Fig. 7 may be associated with the saturating tanks of the other figures. In the case of Fig. 7, this draining passage is shown in vertical position. It may, however, be placed in a horizontal direction or direction inclined to the horizontal and the conveyor carrying the saturated conduits caused to pass therethrough. The draining chamber or passage may be heat insulated and equipped with heating elements and/or cooling means.

After or during draining, the saturated conduits may be moved through cooling chambers or tunnels. Cooling equipment of any well-known type may be associated with such chambers or tunnels or inert gas or air circulated therethrough to expedite cooling of the conduits.

In the apparatus of Fig. 12 container 160 is made relatively deep—50 or 60 feet, or deeper. Tank 2 is disposed within tank 160 as in the other modifications, so that a barometric column of saturant rises in this tank. Conveyor 161 is arranged to travel over sprockets 162 up through the barometric column of saturant into the evacuated space 3 above the column of saturant about sprocket 163 down through the barometric column of saturant, passing into the saturant maintained in tank 160. At a suitable point in the base of the tank the conveyor 161 passes over a sprocket 164 up through the saturant in tank 160 into the barometric column entering the evacuated space 3 and passing over sprocket 165 down through the barometric column. The conveyor belt then passes about sprockets 166, 167, 168 and 169 back to sprocket 162. Sprocket 169 is driven by means of a chain 171 or other drive.

As in the case of the other modifications, tank 160 is provided with the valve control drawoff 23' and an overflow pipe 24' communicating with a tank (not shown). The saturant may be fed to tank 160 through valve control pipe 172. Additional inlets for saturant are shown at 173 and 174.

As the conduit is gradually lowered into the tank 160, the pressure head of saturant thereon gradually increases. Thus, for a tank approximately 50 feet deep the conduit is first subjected to atmospheric pressure, and upon immersion in the saturant, to a pressure slightly above atmospheric. As the conduit is gradually moved up through the saturant in column 2, the pressure is gradually relieved until the conduit reaches the evacuated space 3 at which point it is subjected to vacuum out of contact with the body of saturant. Thereafter the conduit is gradually moved lower and lower into the column of saturant, and the pressure gradually increases, reaching atmospheric, when the conduit nears the base of tank 2. Continued downward movement causes increasing heads of pressure upon the conduit walls until the conduit is at its lowermost point, where it is subjected to a pressure head of about 50 feet of saturant, assuming the tank 160 to be somewhat over 50 feet deep. During the upward movement of the conduit this pressure is gradually reduced. The gradual changes in pressure, I have found, results in maximum impregnation of the conduit walls.

Figs. 13 to 17 show saturating apparatus of the same general type as described in connection with Fig. 12 but depict in greater detail one form of suspension device for individual conduits. As in the case of Fig. 12, container 160 for saturant is of relatively great depth to permit immersion of the conduits in the saturant to subject them to pressure heads of saturant of the order 50 feet or more.

As appears from Fig. 14, the conveyor for moving the conduits through the saturant involves two chains 175 and 176 arranged in spaced relation and disposed to pass over pairs of spaced sprockets. Two such sprockets 178 and 179 are shown at the top of Fig. 14. These sprockets are rotatably mounted on stud shafts 181 extending through stuffing boxes 182 in the walls of tank 2 and rotatably mounted in suitable bearings 183. The chains 175 and 176 may be composed of usual

links employed in chain conveyors. At spaced intervals special links, such as, for example, link 184, shown in perspective in Fig. 17, are inserted in both chains. Links 184 have apertured ears 185 extending upwardly at both sides thereof. A pin 186 is designed to pass through the apertures in ears 185. This pin extends across the space between the conveyor chains 175 and 176 and passes through the ears of the links 184 of both chains. The links are formed at one end with a hooked portion 187 for engagement with a succeeding link of the chain.

One form of container or holder appliance for individual conduits is shown in Figs. 15 and 16.

This holder comprises a strap or rod 188 formed at one end with a hook 189 and weighted at the other end, as indicated by the reference numeral 191. Suspended from the weight 191 is a perforated plate or narrow strap 192 designed to engage the lower end of the conduit shown in section and indicated by the reference numeral 193. The upper end of the conduit is engaged by a perforated belt or strap 194 which may be locked in position on the rod 188 by cotter pin 195 through one of a series of apertures 196 formed in the rod 188. The plurality of apertures in rod 188 permits accommodation of one and the same holding appliance to different length tubes. In operation the tube or conduit is passed over the hooked rod 188 with its lower edge resting on base plate 192. The upper member 194 is then applied and locked in position by pin 195, thus securely holding the tube 193 in vertical position. Any other type of holder for tubes may, of course, be employed.

The holders containing the tubes are suspended from pins 186 at the point indicated by the reference numeral A in Fig. 13, hook 189 engaging pin 186, as appears in Figs. 13 and 14. The tubes are maintained in vertical position with the same end lowermost during the four passes thereof through the saturant in tank 2. The weight 191 minimizes and tends to prevent oscillatory movement of the tubes during the passage through the saturant. Removal of the saturated tubes from the conveyor chain may be accomplished either automatically or manually at the discharge point indicated by the reference numeral B.

Figs. 18 and 19 show one type of mounting for baskets containing tubes. When saturating tubes of different internal diameters, the tubes of smaller diameter may be nested within the larger tubes and the assembly of nested tubes placed within a basket such as 197 of Fig. 18. This basket may be perforated or made of suitable mesh material and is provided with a removable cover 198 having a hook 199 arranged to engage a pin 201 corresponding to pin 186 of Fig. 14. Detents or other fasteners (not shown), which may be spring actuated, are provided on the sides of the baskets, securely locking the perforated or foraminous cover thereon. As in the case of the individual conduit holders of Fig. 13, the basket of conduits of Figs. 18 and 19 are suspended from the pins extending across the space between the conveyor chains and are maintained with the same end lowermost throughout the passage of the conduits through the up and down passes through the saturant.

Figs. 20 to 22 show an arrangement of apparatus for end to end reversal of the conduit during its passage through the evacuated space above the column of saturant. Thus the base end of the conduit passing up through the column of

saturant becomes the top end during the downward passage of the conduits through the saturant. The conveyor of Figs. 20 and 21 involve spaced chains 202—203, preferably of the link type passing over suitable sprockets, one of which, indicated by the reference numeral 204, is shown in Fig. 20. Certain links of the chains are provided with apertured ears through which extend pins 205 and 206 arranged in pairs disposed opposite each other as shown in Fig. 21. Pins 205 are designed to enter into and snugly fit within openings 207 in the strap member 208 constituting a holder for the individual conduits, as will be more fully described hereinafter. Pins 206 pass into elongated openings 209 providing a lost motion connection between pins 206 and strap member 208, and thus permit the necessary movement of the pins with respect to the conduit holders as the conduits pass about the sprockets.

Strap member 208 has welded, or otherwise suitably secured thereto a stepped base member 211 for reception of the lower end of the tube or conduit shown in section and indicated by the reference numeral 212. Pivoted to the top of the strap member 208, as at 213, is one end of a cover member 214. The other end of this cover member is arranged to be locked to the strap member by a cotter pin 215 or other suitable locking device. A stepped member 216 is suitably secured to the cover plate 214. The stepped members 211 and 216 permit the employment of the tube holder with tubes of different internal diameters and at the same time securely hold the tubes in desired position within the holder.

Baskets containing a plurality of tubes may be mounted, as shown in the case of the individual holders of Figs. 20 to 22 and the baskets containing conduits thus reversed during their travel between up and down passes through the saturant.

The apparatus of Figs. 23 and 24 will be found admirably suited for the saturation of conduits in plants where very large quantities of conduits require saturation. This apparatus involves two large tanks 221 and 222 spaced apart and each provided with a valve controlled drawoff 223, an overflow pipe 224 near the top thereof and a pitch or other saturant pipe feed line 225. Extending up from each tank is a tubular member composed of legs 226 and 227, this member preferably being of the shape shown in Fig. 23. The lower ends of legs 226 and 227 are open and dip beneath the saturant in tanks 221 and 222, the level of saturant therein being at all times maintained above the exit point from the legs 226 and 227, so that these legs are sealed by the liquid saturant within the tanks against the atmosphere. The base or floor plate 228 of the tubular member at both ends thereof is extended through the tank, as indicated by the reference numeral 229 onto a platform 230. The platform 230 as well as the floor portion 228 of the tubular member are provided with a suitable track over which cars 231 may readily pass. The tracks extend from one tank 221 up through leg 226, down through leg 227 through tank 222 onto a platform 230 and back to the tank 221. A series of cars 231, as shown in Figs. 23 and 24 are designed to travel onto the tracks being moved continuously or intermittently through the apparatus, a suitable cable or chain 232 passing between the tracks and over sheaves 233—234 rotatably mounted adjacent tanks 221 and 222, respectively. Sheave 233 may be driven from a

suitable source of power indicated by the belt 235 in Fig. 24.

The top of tubular member constituted of legs 226 and 227 is connected to a vacuum pump (not shown). The tubular member is of such height, i. e., the point represented by reference numeral 236, extends above the level of saturant in tanks 221 and 222 to such height that a maximum barometric column of saturant may be maintained in the legs 226 and 227. For coal tar pitch having a specific gravity of 1.2 this height should be in excess of 28 feet so that an evacuated space, indicated by the reference numeral 237, may be provided.

The cars may be loaded with the conduits in vertical position, as indicated in Fig. 23, just prior to their passage into tank 221, then caused to travel through tank 221, up through the column of saturant in leg 226 into the evacuated space 237, down through the column of saturant in leg 227 into the tank 222, and thence out of this tank, returning to tank 221. During the travel of the cars from tank 222 to 221 they may be passed first through heated and then through cooled zones to expedite the draining and cooling of the conduits.

During the passage of the conduits through the evacuated space 3, the conduits may be showered with saturant by means of sprays disposed in the top of space 3. Such sprays are indicated by the reference numeral 249 in Fig. 13. It will be understood that, if desired, sprays may be provided in the corresponding evacuated spaces of the other figures of the drawings and that saturant may be pumped from the base of the container to the sprays as shown for example in the case of the apparatus of Fig. 28, hereinafter described in detail.

In the modifications of this invention shown in Figs. 1 to 11, inclusive, a barometric leg of saturant is maintained under vacuum in the saturating tank, liquid sealed at its base, through which leg the articles to be saturated are moved. In Figs. 25 and 26 is shown apparatus for saturating conduits in which a column of saturant is provided in a tank sealed against the atmosphere. Hence, a column of saturant of any desired height may be maintained in this tank and the tank need not be of a height sufficient to accommodate a maximum barometric leg of saturant, in the case of coal tar pitch of specific gravity of 1.2 at least 28 feet high, since the device is sealed mechanically and with fluid against ingress of air.

Referring to Fig. 25, tank 101 is shown in which any desired level of pitch or other saturant may be maintained constant by a float-controlled valve 100 regulating the discharge of saturant from the tank 101 through pipe 110 which connects with the valve-controlled drawoff 113 at the base of the tank. Disposed within this tank is an endless conveyor 102 passing over sprockets 103 suitably mounted in the tank. Conveyor 102 is shown provided with clamps or supports 104 at spaced intervals therealong and at opposite sides thereof arranged to support and feed the fibrous conduits through the saturant in tank 101; other means for holding the tubes may be employed.

A rotary feed device 105 delivers the tubes from entry chute 106 to the clamps 104 on the conveyor 102. This feeder comprises a casing 107 in which a rotor 108 having pockets 109 is rotatably mounted. Only a small clearance 111 is provided between the rotor 108 and the casing 107. This clearance is maintained sealed by the

continuous feed of pitch or other saturant through valve-controlled pipe 112. The conduits are moved by the rotor from the entry chute 106 to the discharge point where spring pressed plungers 114 within the rotor 108 are forced outwardly by a cam or eccentric 115 causing the fibrous conduit to be discharged from the rotor into the tank 101.

Movement of conveyor 102 may be continuous or intermittent, and synchronized with the movement of rotor 108 so that as each clamp 104 is brought into position the plungers 114 effect the discharge of a fibrous conduit therinto. The conveyor elevates the conduits through the column of saturant in tank 101 into the evacuated space 116 thereabove. Vacuum in tank 101 may be created by a vacuum pump (not shown) communicating with tank 101 through pipe 118. From the evacuated space 116, the conveyor moves the conduits down through the column of saturant in tank 101. The clamps may be formed in any well known manner so that the conduits are held seated therein during the downward movement thereof. Upon the conveyor reaching the position 119, suitable cams or other mechanism cause the clamps to disengage the conduits and permit their discharge into the pockets 122 of a rotor 123 rotatably mounted in casing 124. A guide plate 121 disposed between clamps holding the opposite ends of the tubes aids the discharge of the tubes or conduits. Rotor 123, like 108, has but a small clearance between its end and side walls and casing 124, which is maintained sealed by liquid saturant. Movement of rotor 123 brings the pockets 122 into registry with the clamps discharging the saturated conduits.

Approximately the same amount of saturant is fed to tank 101 as will be absorbed by the conduits and discharged by rotor 123. If by chance more pitch is introduced than the conduits will absorb and the rotor discharge, the level of the saturant may be held constant by withdrawing pitch through float controlled valve 100.

Instead of having the tank 101 arranged in a vertical direction with feed and discharge rotors located at the base thereof, the tank may be located in a horizontal direction with the feeder at either the top or bottom, and the discharge rotor in either the bottom or top respectively. The tubes may be fed in a horizontal or vertical position. In lieu of a rotary type feeder and discharger, reciprocating plunger or caisson-lock type feeders and dischargers sealed against ingress of air may be employed.

As shown in Fig. 27, one side of casing 107 may be provided with an inlet pipe 241 for saturant and the other side with an exit pipe 242. Side walls 243 of the rotor 108 are formed with apertures 244 registering with pockets in the rotor. As opening 244 of each pocket comes into registry with inlet pipe 241 and exit pipe 242 a stream of saturant such as pitch is forced axially through the pipe and about the outer walls thereof, washing the pipe. This insures that a relatively clean fibrous conduit is delivered to the body of saturant maintained in tank 101 and washes out any entrapped air.

The apparatus of Fig. 25, it will be noted, may be employed for pressure saturation of fibrous conduits. Pressure may be built up in tank 101 by introducing pitch or inert gas into the tank until the desired pressure is created and the

conduits passed continuously through the saturant maintained under pressure.

In the apparatus of Fig. 26, an elliptical shaped container having an elliptical shaped passageway 131 is utilized. Cable or chain 132 having seal members 133, preferably of flexible material spaced at regular intervals thereon, is arranged to travel through the elliptical shaped passageway in container 131. Chain 132 may be driven by a sprocket 130 rotated from a suitable source of power. The sprocket is provided with openings 140 into which sealing members 136, connected by the chain, pass as the sprocket rotates. Other driving mechanism for the chain may be employed. Movement of conveyor 132 causes the conduits, preferably disposed with their longitudinal axis in alignment with the longitudinal axis of the passageway, to enter the preliminary drying portion 135 of the passageway. The sealing member indicated on the drawings by reference numeral 136 maintains sealed the passageway with respect to opening 134. The drying portion 135 comprises a foaming chamber communicating, through pipe 141, with condenser 142. The foaming chamber is maintained under vacuum by means of pump 139. Moisture and occluded gas removed from the conduits pass from the foaming chamber to condenser 142 where condensable constituents are condensed. The foam chamber may be operated at atmospheric pressure and may be vented through line 156 to a condenser (not shown).

Continued movement of conveyor chain 132 moves the conduits into and through the saturant in tank 137 in which a substantially constant level of saturant is maintained under vacuum, excess saturant overflowing through valve-controlled line 138 leading to a drain tank or other disposal point. The vacuum is maintained in tank 137 by means of a vacuum pump 139 connected to the tank 137 by a line 141 leading through a condenser 142. Oils coming off from the saturant are condensed in 142 and may be returned to the system or otherwise utilized. The saturated conduits upon leaving tank 137 are moved through the lower run to opening 134' where the saturated conduits may be removed. The passageway 131 is made of sufficient diameter to permit the passage of the conduits through the curved portions thereof.

Pitch or other saturant may be continuously introduced into the system by a pump 145 through valve-controlled lines 146, 147, and 148, the pitch introduced being sufficient in amount to completely fill the drying zone of the passageway and maintain a level indicated by the reference numeral 149. Excess pitch flows off through lines 151 and 152, returning to tank 153 from whence it was pumped into the passageway.

The passage of the conduits through the hot saturant in zone 135 results in the drying of the conduits prior to their introduction into the saturant maintained under vacuum in tank 137. The conduits are maintained in contact with the saturant throughout a prolonged path of movement occasioned by the length of the passageway 131. If desired, conveyor 132 may be arranged to carry the conduits into the evacuated space 155 above the level of pitch so that the conduits are subjected to vacuum out of contact with the pitch between periods of contact with the pitch saturant. A second conveyor may be associated with conveyor 132 and disposed in tank 137 arranged to remove the conduits from conveyor 132, move them up to evacuated space

155, down through the saturant in tank 137, and finally return the conduits to conveyor 131. The level of saturant in container 137 may be changed by moving the overflow up or down to the desired height.

The tank 137 may be made of such height as to require no regulator for the level of pitch; i. e., the pitch may be allowed to rise to its maximum barometric level. In the latter event, the saturating tank 137 will be sealed against air leaks by the pressure of pitch introduced through 147 and the constant level of pitch maintained at 149 and subjected to atmospheric pressure. The pitch forms a liquid seal between the moving members 133 and the passage 131.

Instead of passing the conduits through a body of saturant maintained under vacuum, the saturant may be sprayed onto the conduits while the latter are subjected to vacuum. The apparatus of Fig. 28 may be employed to practice such process. This apparatus is in general similar to that of Fig. 25, except that the conveyor does not pass through a body of saturant. Corresponding parts of the apparatus of Figs. 25 and 28 are indicated by like reference numerals. In the apparatus of Fig. 28 a pump 246 is provided for forcing saturant to sprays 248 which shower the saturant over the conduits. Sprays (not shown) are arranged to direct the saturant axially through the conduits as well as spray the saturant over the conduit walls. Excess saturant falls to the base of tank 101 from whence it is withdrawn by pump 246 and passed back to the sprays 248. Additional saturant may be fed to the intake end of the pump 246 by means of a valve-controlled pipe 247. The level of saturant in the base of tank 101 is not permitted to rise above a predetermined point by float-controlled valve 250 disposed in a line communicating with the drawoff 23' which leads to a storage tank (not shown). The saturated conduit is removed from the tank by means of a rotor 123 as in the case of Fig. 25.

Instead of having the loading and discharge stations on opposite sides of the saturating tank, these stations may be disposed on one and the same side. Such apparatus is shown in Fig. 29 in which one side only of saturating tank 2 dips into the saturant in container 1, the back or opposite side of tank 2 indicated by the reference numeral 251 being continuous with the back of container 1. Both the loading and the discharging of the conveyor takes place at the side indicated by the reference numeral 252. The conveyor carries the fibrous conduit first into the saturant in container 1, up through the saturant in tank 2, into the evacuated space 3, down through the saturant in tank 2, back through the saturant in container 1, and out of the saturant at the side 252 where it entered the saturant.

It will be noted that in accordance with this invention, a series of conduits are moved progressively through the drying chamber or zone, e. g., chamber 51 of Fig. 7 or path 65 of Fig. 8, while previously introduced conduits are moved progressively through the saturant. The individual members of the series are thus at different stages of drying or saturation, the conduits entering the drying and saturating zones containing more or less moisture and being relatively unsaturated whereas the conduits leaving these zones are completely dried and saturated, respectively. The rate of passage of the conduits through the drying zone is substantially the same as the rate of passage of the dried conduits through the saturating zone and the rate of with-

drawal of the saturated conduits from the saturating zone so that the conduits, even when the operation is of the intermittent or interrupted type, are in effect continuously fed through the drying zone, the saturating zone, and withdrawn from the latter. From the aspect of what takes place in the apparatus during any moment of operation, it will be noted that one series of conduits are moved progressively through the drying chamber or zone while a second series of conduits are moved progressively through the saturant. The individual members of both series are at different stages of drying or saturation, the conduits entering the drying or saturating zones containing more or less moisture being relatively unsaturated, whereas the conduits leaving these zones are dried and saturated, respectively.

Conduits saturated in accordance with this invention having initially about 9 per cent moisture and a porosity of about 1.6 cc. of voids per gram of conduit wall, with a coal tar pitch of a specific gravity of 1.23 at 60° F., a melting point of 158° F. (cube in water) and a "free carbon" content of 6.4 per cent, the temperature of the saturant being maintained at about 320° F., absorbed on a bone dry basis 258 per cent saturant. Sections from the extreme ends of this conduit immersed in distilled water for forty-eight hours showed a percentage of absorption of 0.78 per cent for the section through the top and 0.40 per cent for the section through the bottom.

Prior procedures of saturating conduits required the handling of from 400 to 600 tons of saturant in the system. The process of this invention, for corresponding capacity, will require the use of less than 100 tons of saturant, and consequently materially reduces the amount of saturant that must be kept in storage and permits relatively more rapid renewal and freshening of the saturant.

It will be noted that the process of this invention is continuous, of high capacity, capable of automatic regulation, requires a minimum of saturant for its practice, and results in uniformly saturated conduits of improved water-proofness.

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 continuous process of saturating short lengths of fibrous conduits having relatively rigid walls of substantial thickness and density and constituted of organic fibrous material with a bituminous saturant in heat liquefied condition, which saturant upon prolonged contact with the conduits at saturating temperatures would cause substantial thermal deterioration of the walls thereof, which comprises providing a body of saturant with an endless conveyor leading into and out of the saturant, maintaining the body of said saturant in heat liquefied condition with a substantial portion thereof at a pressure substantially less than atmospheric, continuously conveying the conduits without flexing them through the body of saturant so that the head of saturant maintained on the conduits gradually decreases until the conduits are subjected to substantially no head of saturant, then conveying the conduits through the saturant until they are subjected to a pressure head at least equal to atmospheric, and removing the saturated conduits from the conveyor, the time of contact between the conduits and the saturant in their passage therethrough being insufficient to cause substantial thermal

deterioration of the conduit walls but sufficient to substantially completely fill the voids in said conduit walls.

2. The continuous process of saturating individual fibrous conduits having relatively rigid walls of substantial thickness and density and constituted of organic fibrous material with a bituminous saturant in heat liquefied condition, which saturant upon prolonged contact with the conduits at saturating temperatures would cause substantial thermal deterioration of the walls thereof, which comprises maintaining a barometric column of saturant in heat liquefied condition and with an evacuated space thereabove, providing a conveyor leading into and out of said saturant, continuously conveying the conduits without flexing them through the column of saturant so that the head of saturant maintained on the conduits gradually decreases from somewhat above atmospheric until the conduits are subjected to substantially no head of saturant, then conveying the conduits into the evacuated space, conveying the conduits from the evacuated space through the saturant until the pressure head thereon increases to a point at least equal to atmospheric, and removing the saturated conduits from the conveyor, the time of contact between the conduits and the saturant in their passage therethrough being insufficient to cause substantial thermal deterioration of the conduit walls but sufficient to substantially completely fill the voids in said conduit walls.

3. The continuous process of saturating fibrous conduits having relatively rigid walls of substantial thickness and density and constituted of organic fibrous material with a bituminous saturant in heat liquefied condition, which saturant upon prolonged contact with the conduits at saturating temperatures would cause substantial thermal deterioration of the walls thereof, which comprises maintaining a barometric column of saturant in heat liquefied condition with an evacuated space thereabove, continuously moving the conduits through the column of saturant so that the head of saturant maintained on the conduits gradually decreases from not less than atmospheric until the conduits are subjected to substantially no head of saturant, then moving the conduits into the evacuated space, spraying the conduits with saturant while in the evacuated space, then moving the conduits through the saturant until the pressure head thereon increases to a point not less than atmospheric, and removing the saturated conduits from the saturant, the time of contact between the conduits and the saturant in their passage therethrough being insufficient to cause substantial thermal deterioration of the conduit walls but sufficient to substantially completely fill the voids in said conduit walls.

4. The continuous process of saturating individual dense paper conduits having relatively rigid walls of substantial thickness with a coal tar pitch saturant in heat liquefied condition, which saturant upon prolonged contact with the conduits at saturating temperatures, would cause substantial thermal deterioration of the walls thereof, which comprises maintaining a barometric column of coal tar pitch under vacuum, providing a conveyor leading into and out of said column of coal tar pitch, conveying the conduits without flexing them through the column of coal tar pitch so that the head of pitch maintained on the conduits gradually decreases from somewhat

above atmospheric pressure until the conduits are subjected to substantially no head of pitch, then conveying the conduits through the evacuated space above said column of pitch, thereafter conveying the conduits through the column of pitch until the pressure head thereon increases to a point not less than atmospheric, removing the saturated conduits from the conveyor, the time of contact between the pitch and the conduits in their movement through the column of pitch being insufficient to cause substantial thermal deterioration of the conduit walls but sufficient to substantially completely fill the voids in the conduit walls.

5. The continuous process of saturating individual fibrous conduits having relatively rigid absorbent walls of substantial thickness and density with a bituminous saturant, which comprises providing a body of said saturant in heat liquefied condition under a pressure substantially less than atmospheric, providing a conveyor leading into and out of the said body of saturant maintained at less than atmospheric pressure, gradually and continuously conveying said conduits without flexing them through the body of saturant whereby the saturant enters and fills the voids in said conduits, and removing the saturated conduits from the conveyor after it leaves said body of saturant maintained at less than atmospheric pressure.

6. The continuous process of saturating individual absorbent articles which comprises maintaining a column of saturant in heat liquefied

condition under vacuum, continuously introducing the articles to be saturated into the base portion of the column of saturant, immersing the articles in said saturant, progressively moving them up therethrough and subjecting them to vacuum conditions out of contact with the body of saturant, spraying the articles with saturant while subjected to said vacuum conditions, then moving the articles down through said column of saturant and removing the saturated articles from the saturant.

7. The continuous process of saturating individual absorbent articles which comprises continuously drying a series of said articles, the individual members of the series being at progressively different stages of drying, continuously passing said series of dried articles through a body of saturant maintained with an evacuated space thereabove, the individual members of the series being immersed in the saturant and subjected to different pressure heads of saturant, moving members of the series from the saturant into the evacuated space while introducing further members of the series into the saturant at a rate corresponding to the rate of withdrawal of individual members of the series from the saturant, spraying the members of the series in the evacuated space with saturant while moving therethrough, moving members of the series from the evacuated space through a body of saturant and then withdrawing them from the body of saturant.

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