Jan. 15, 1929.

1,698,886

R. T. JOHNSTON

METHOD AND APPARATUS FOR SATURATING FIBROUS MATERIAL

Filed March 20, 1923 3 Sheets-Sheet 1

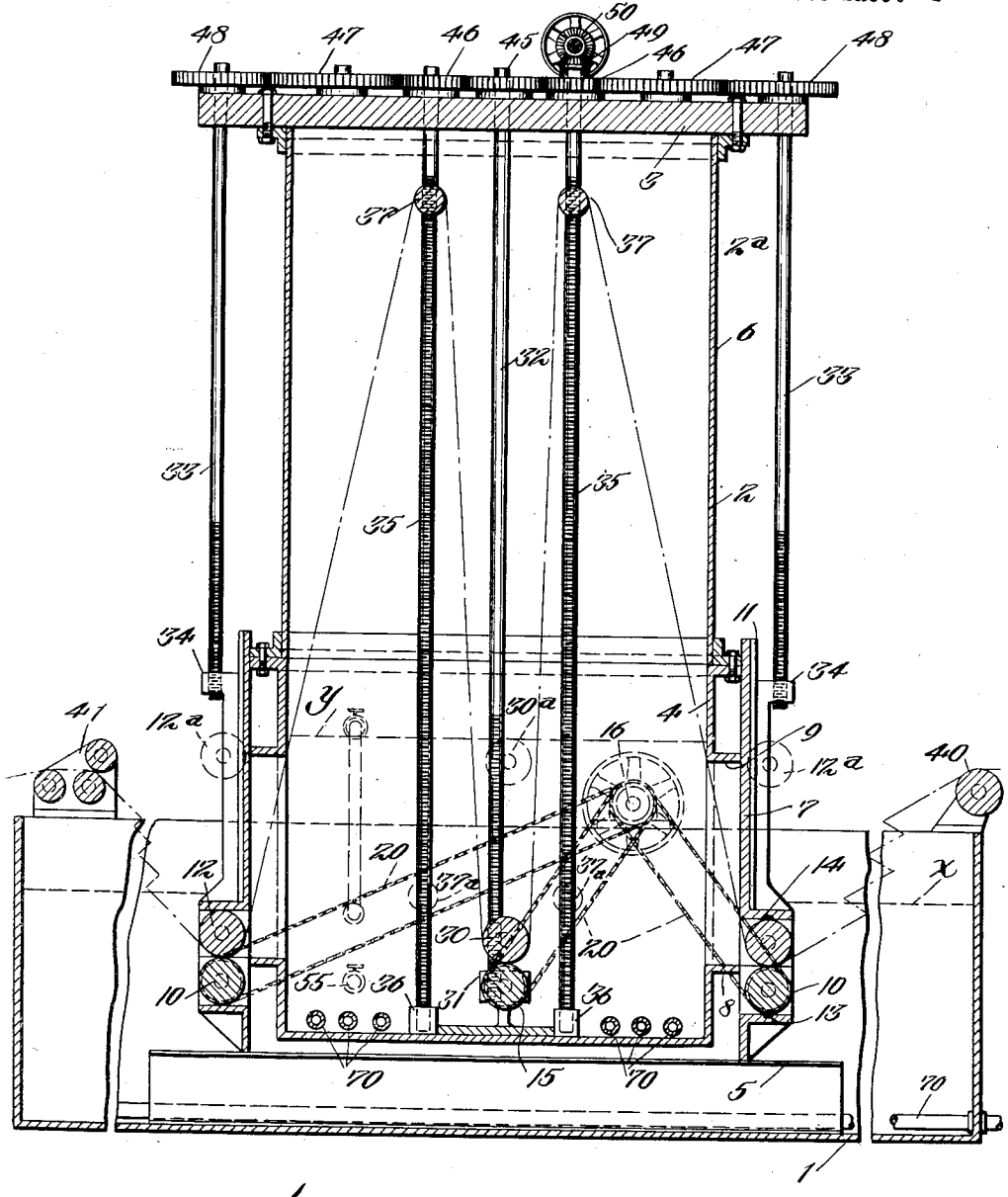


Fig. 1.

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METHOD AND APPARATUS FOR SATURATING FIBROUS MATERIAL

Filed March 20, 1923 3 Sheets-Sheet 2

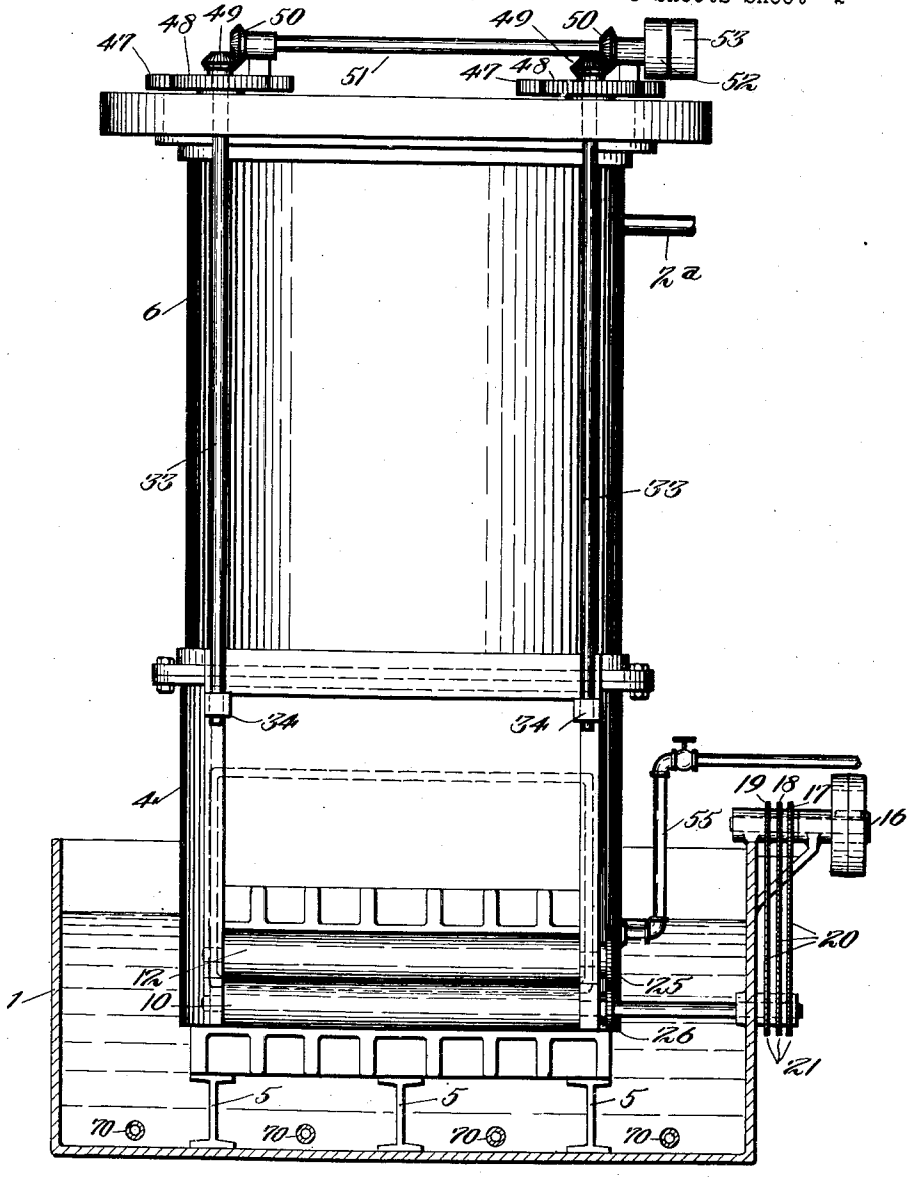


Fig. 2.

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Filed March 20, 1923 3 Sheets-Sheet 3

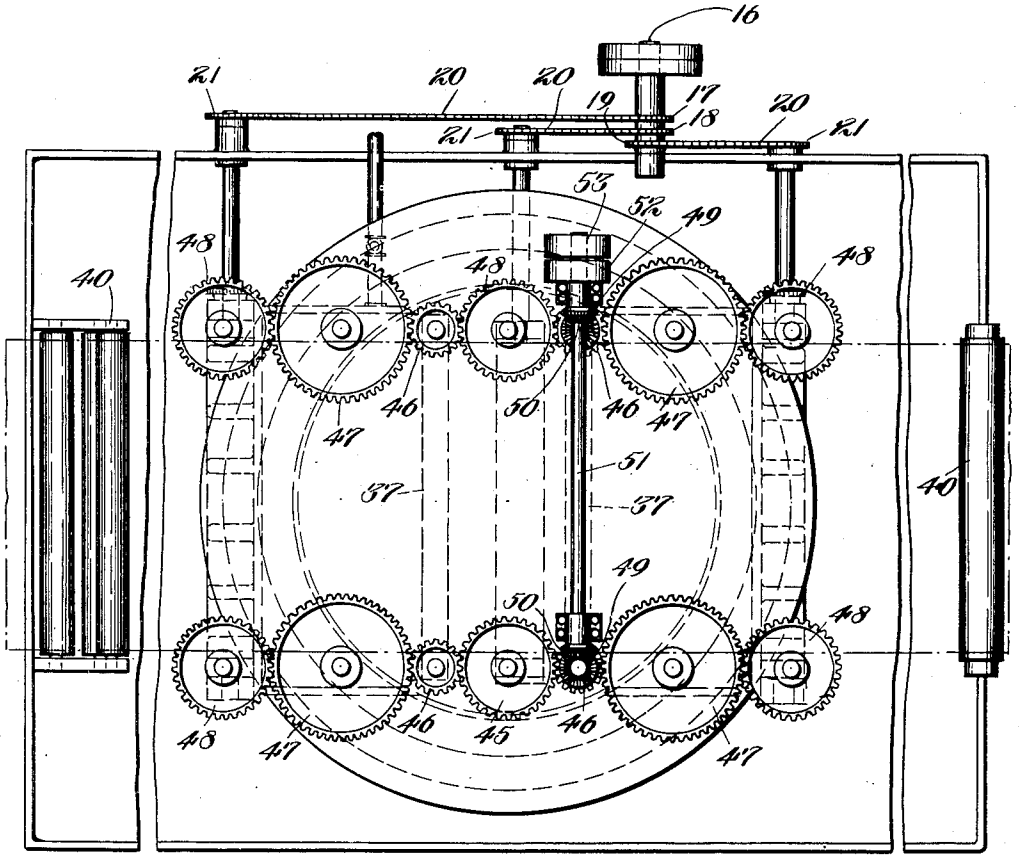


Fig. 3.

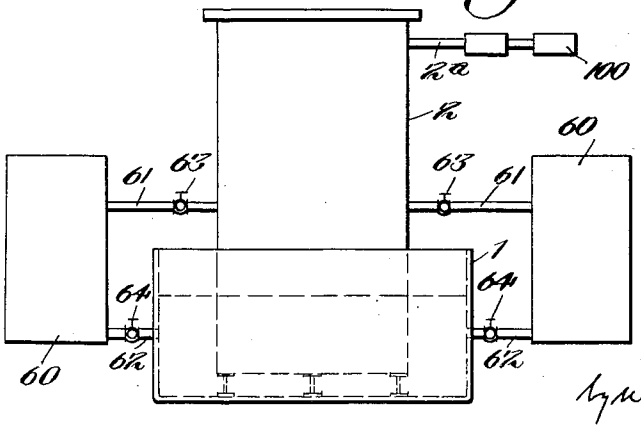


Fig. 4.

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Patented Jan. 15, 1929. 1,698,886

UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR SATURATING FIBROUS MATERIAL.

Application filed March 20, 1923. Serial No. 626,439.

This invention relates to an improved method and apparatus for drying and saturating fibrous material. In the manufacture of asphalt roll roofing or shingles, which are commonly made of felt, treated, impregnated and coated with asphalt and often surfaced with granular material, much difficulty has been experienced in sufficiently impregnating the material to render it durable, insufficient saturation resulting in swelling and shrinking of the material and curling of the edges when exposed to the variable temperatures and humidity conditions to which such material is subjected when in use.

As the felt leaves the paper machine it commonly contains moisture up to 6% and it is found that if some of this moisture is driven off, the felt has a marked affinity for moisture and reabsorbs from the atmosphere substantially the amount driven off in a very short time. The presence of moisture, however, acts to hinder the proper saturation of the felt. Air is also present in the voids of the felt and this also must be expelled to make room for the saturant.

In order to overcome these difficulties the present invention utilizes the heat of the asphalt itself to expel the moisture, the asphalt being driven into the felt by repeated treatment until its innermost fibers are thoroughly heated and dried. The felt is also subjected to vacuum conditions by which the air and vapors are drawn out. The vacuum also acts as a non-conductor of heat so that the heat of the asphalt is more effective in vaporizing the moisture and to lower the vaporization temperature of the moisture so that its expulsion by the hot asphalt is accelerated and rendered more complete. After the vacuum treatment the felt is passed through the heated asphalt at atmospheric pressure before it reaches the atmosphere, this acting to force the asphalt into the fibers under the equivalent of a fluid pressure equal to the difference between the vacuum and atmospheric pressures, and which also acts to coat the surface of the felt so that it is in proper condition to receive its surfacing of granular material such as ground slate.

In carrying out this process the length of time for treating the felt with the asphalt may be materially shortened over that required for the more or less imperfect saturation produced by passing it through an open tank of saturant as is now generally practiced. Consequently an asphalt of higher melting point may be employed without danger of damaging the felt, so that a product less susceptible to atmospheric temperature conditions results. It also makes possible the use of blown asphalt for both saturating and coating so that there is no danger of an imperfect bond between the saturant and the coating as is sometimes the case where one quality of asphalt is used for saturating and another for coating. Blown asphalt is quite viscous even when melted so that it would be quite difficult to properly saturate the felt by the open tank method even if the felt were able to withstand the high temperature for a considerable period. Moreover, the blown asphalt is of a rubbery consistency under atmospheric temperatures and does not materially soften under extreme heat or become brittle when cold and is therefore much better for roofing purposes than asphalt of lower melting point.

For a more complete understanding of this invention, reference may be had to the accompanying drawings in which

Figure 1 is a longitudinal vertical section through a form of apparatus designed for carrying out the process.

Figure 2 is an end elevation partly in vertical section of the same.

Figure 3 is a top plan.

Figure 4 is a diagrammatic view showing a method of handling leakage into the vacuum chamber.

Referring to these Figures, 1 indicates an open top tank which is shown rectangular in plan and in which is positioned the lower end of a vacuum chamber 2 which is closed at its upper end by a cover 3, and designed to be connected to any suitable vacuum-producing means 100 (Fig. 4) as through a pipe 2^a. As shown the chamber is formed by a lower section 4 resting on a foundation of structural beams 5 and to the top of which is fixed an upper cylindrical section 6. The lower section 4 is formed with oppositely disposed openings 7 in its side wall, the lower end of each opening as at 8 being below the level of the saturant in the tank 1, which is shown as at x, and the upper end 9 of each opening being considerably above the level of the saturant. Adjacent the lower end of each opening is journaled a feed roll 10. Vertically slidable

opposite each opening 7 for closing the same is a gate member 11 having journaled at its lower end a roll 12 which cooperates with the roll 10 when the gate is in its lowered position to feed sheet material therebetween into or out of the chamber 2. In order to prevent some of the leakage between the tank and the chamber, wipers 13 and 14 may be carried adjacent these rolls and resting thereon as shown.

Arranged in parallel relation to the rolls 10 is a lower feed roll 15 journaled within the lower section 4 of the chamber and beneath the level of saturant therein. The rolls 10 and 15 may be driven to feed the felt by any suitable means, as herein shown a shaft 16 journaled at the upper edge of the tank 1 being provided with sprocket wheels 17, 18 and 19 from which extend sprocket chains 20 passing over suitable sprocket wheels 21 fixed to rotate with the rolls. The rolls 12 may be power driven by gears 25 thereon meshing with gears 26 fixed to rotate with the rolls 10 when the gates 11 are in their lowered position.

Cooperating with the roll 15 is an upper roll 30 which is journaled in blocks 31 through which pass vertically extending screws 32. By rotating these screws the roll 30 may be raised and lowered relative to the roll 15. When in lowered condition this roll 30 may be driven from the roll 15 by intermeshing gears fixed to these rolls in the manner of the gears 25 and 26 for the rolls 12 and 10. Gates 11 are also designed to be raised and lowered by the rotation of screws 33 journaled in the head 3 of the chamber and threaded in lugs 34 extending from the gates.

Intermediate the sets of rolls 10 and 12 and 15 and 30 are positioned other vertical threaded rods 35 also journaled at their upper ends in the cover 3 and journaled in step bearings 36 in the base of the chamber, and threaded on these rods 35 are guide bars 37 which may be moved vertically within the chamber by rotation of the rods 35. The felt to be saturated is passed over a guide roll 40 at one end of the tank 1 and from there passes down between the adjacent pair of rolls 10 and 12 through one of the openings 7 and into the chamber 2 beneath the level of the saturant. The felt then passes upwardly over one of the bars 37, then downwardly between the rolls 15 and 30, then upwardly over the other bar 37 and down through the other opening 7 and between the opposite pair of feed rolls 10 and 12, then upwardly out of the saturant and through the guide and squeeze rolls shown at 41, which may also serve as doctors to regulate the thickness of the coating left on the sheet before it is to be coated with the granular surfacing.

As the asphalt when in use is very hot the felt may be immersed therein for a very short period only without damaging the fibres, and for this, as well as for convenience in threading, it should be removed from the asphalt immediately when the machine is to be stopped. For this purpose the upper feed rolls 12 and 30 are vertically movable out of the saturant by turning the screw rods 32 and 33 and at the same time the bars 37 may be lowered. The positions of these members are then indicated by the dotted circles 12^a, 30^a and 37^a. All the upper feed rolls are then above the level of saturant within the tank and the bars 37 are either above or substantially on the level with the saturant while the openings 7 are substantially unobstructed by the gates 11. It is therefore an easy matter to thread the felt over the roll 40 beneath the upper guide roll and above the bars 37 entirely through the chamber 2 in a straight path. The various rollers and bars are then returned to their normally operating conditions, when the machine is started, and the felt is submerged beneath the saturant where it enters and leaves the chamber 2 and between the rolls 15 and 30 and is above the level of the saturant where it passes over the bars 37. It will thus be seen that the material may be fed through in a straight path, whereupon the various guide and feed members may be so moved relative to each other that the material may take its proper path through the apparatus.

In order that these various members may be moved simultaneously either to their threading or normal operating positions, the various threaded rods 32, 33 and 35 are geared together for simultaneous rotation. For this purpose the rods 32 carry gears 45 thereon which mesh with gears 46 carried by the rods 35. Also meshing with the gears 46 are idler gears 47 which mesh with gears 48 fixed to the rods 33. One of the opposite pairs of rods 35 may have fixed thereto at their upper ends beveled gears 49 meshing with beveled gears 50 fixed to a horizontal operating shaft 51 to one end of which may be fixed the tight and loose pulleys 52 and 53.

The chamber 2 is designed to be connected with any suitable vacuum-producing apparatus so that a good commercial vacuum may be produced above the level of the saturant therein. The normal level is designed to be about at the line *y*. The feed rolls 10 and 12 form a narrow throat through which the felt is fed into and out of the vacuum chamber 2, and, while it is evident that a certain amount of leakage will occur as the felt passes through these throats, saturant is absorbed by the felt in its passage through the vacuum chamber and is removed therewith as it leaves the chamber between the opposite rolls 10 and 12. Leakage also occurs between the edges of the felt sheet and the ends of the throat which must be made somewhat longer than the width of the sheet material since when the felt is being saturated it is in a comparatively limp and soft condition so that it can not be

easily guided laterally as it passes through the apparatus and hence some leeway for weaving of the sheet lengthwise of the throat must be provided. Should this leakage be insufficient to maintain the level of the saturant within the vacuum chamber at the desired point, additional saturant may be supplied through a pipe shown at 55.

Should there be an excessive amount of leakage the level of the saturant may be kept at the desired point below the level due to the barometric head of saturant, above the level x in the tank by a mechanism shown diagrammatically in Figure 4. This mechanism comprises one or more tanks as shown at 60 which may be connected at will to the interior of the vacuum chamber 2 at the level at which it is desired to keep the saturant in this tank as through an overflow pipe 61, or through a pipe 62 with the tank 1. By shutting off the pipe 62, as by a valve 64, saturant may overflow from the chamber 2 into the tank 60, and then, by shutting off the pipe 61 as by means of the valve 63 and opening the valve 64, the overflow may be led back into the tank 1. By providing a pair of such overflow tanks 60 one may be kept in communication with the vacuum chamber while the other is in communication with the tank, and, as the tank in communication with the vacuum chamber becomes filled, the opposite tank may be connected thereto while the filled tank may be opened to the tank 1. By providing the tank 60 of sufficient capacity, it may be left open to the vacuum chamber during the operation of the machine and may be disconnected therefrom and opened to the tank 1 when the apparatus is to be shut down.

Means may be provided for heating the saturant in the tank and chamber, such means being indicated by pipes as at 70 through which a heating agent may be circulated.

As the sheet material passes into the tank 1 and beneath the surface of the hot saturant much of the moisture near the surface of the sheet is vaporized and driven off and the material becomes coated thereby, and in passing between the rolls 10 and 12 this coating of the hot saturant is forced more or less into the voids between the fibers of the felt, thus serving to raise the temperature of the fibers so as to vaporize moisture thereon. As felt is an extremely good non-conductor of heat, due to the air-filled voids, it is otherwise extremely difficult to heat the fibers except those directly exposed on the outer surface thereof. These squeezing rolls 10 and 12, however, force the hot saturant sufficiently into the voids between the fibers as to heat up fibers inaccessible to surface heat treatment. As the felt then passes above the surfaces of the saturant within the vacuum chamber, the vapor has a chance to escape from the felt, the vacuum materially lowering the vaporizing temperature thereof, and the air under atmospheric pressure within the voids of the felt expanding and escaping therefrom helping to carry the vapors therewith. As a vacuum forms a good non-conductor of heat, the heat applied to the fibers by the hot saturant which has been more or less forced into its voids is not readily dissipated therefrom, but is effective in vaporizing the moisture. After passing over the first guide bar 37, the felt sheet is then brought again beneath the surface of the hot saturant and between the squeezing rolls 15 and 30. As it passes into the saturant again its surface becomes coated therewith and the rolls act to force the saturant further into the felt, thus causing the hot saturant to act on fibers still further removed from the surface of the felt, and which may not have been hitherto reached, and effecting vaporization of the moisture therein which is then allowed to escape together with additional air in the interior voids as the felt again emerges from the saturant into the upper portion of the chamber 2 under vacuum conditions.

As the felt passes from this second guide bar 37, it is again immersed beneath the saturant and passes between the outgoing feed rolls 10 and 12 which also act to force saturant into the body of the felt. The felt then emerges into the saturant in the tank 1 which is at atmospheric pressure so that saturant is forced therein by reason of the atmospheric pressure being in excess of the pressure within the vacuum chamber. Thus if the vacuum is less than atmospheric by twelve pounds pressure, the pressure acting to force the saturant into the felt as it passes through the saturant in the tank 1 after being treated within the vacuum chamber is also twelve pounds. Not only does this last passage through the saturant act to saturate under pressure as above described, but it also imparts thereto a coating of the saturant the thickness of which is regulated by the doctor rolls 41 as the felt finally leaves the tank. By this method of treatment the time required for thoroughly saturating the felt may be very much shortened over that now required for the more or less imperfect saturation produced by passing the material through an open tank containing melted saturant. Furthermore the actual length of felt being treated at any one time is materially shortened, and, as the material passes through the apparatus in looped formation, the total length of the apparatus is still further reduced.

Due to the decreased time in which the felt is subjected to the hot saturant, it is possible to employ a saturant of a higher melting point than ordinarily employed without causing the fibers of the felt to be injured from the extreme temperature. It is entirely feasible, therefore, to employ high melting

point asphalts such as blown asphalt which is physically better adapted to withstand weather conditions than lower melting point asphalts. Under ordinary atmospheric temperatures this blown asphalt is of a somewhat rubbery consistency which does not become soft and sticky under considerable heat nor does it become brittle when subjected to extreme cold. This is the type of asphalt ordinarily employed heretofore for surfacing but it has not been found practicable in the open tank saturating methods to use it as the saturating medium, since besides having a high melting point it is so viscous as to resist saturation by immersion.

Where two grades of asphalt are used, one for saturating and the other for coating, some difficulty has been experienced in causing a close bonding of the coating with the saturant. With the present method and apparatus, however, blown asphalt may be employed for both purposes so that no problem of the bonding of different grades of asphalt arises.

By causing the rate of feed of the asphalt into the vacuum chamber to be regulated as above described, it is unnecessary to provide a vacuum chamber of the height of a column of the asphalt equal to the barometric height due to the vacuum, with sufficient room in addition for treatment of the material out of the saturant under vacuum conditions between successive immersions in the saturant. The height of the entire apparatus may thus be considerably reduced over what would otherwise be necessary. Thus, a tank seven feet high may provide a path for the sheet of about forty feet in length with a single pair of pressure rolls within the vacuum chamber. Of course, if desired, more than one pair of pressure rolls may be employed within the vacuum chamber, thus increasing the number of immersions and treatments under vacuum of the sheet as much as may be desired, and, if it is desired to increase the length of the path in order to attain a higher operating speed, the vacuum chamber may be increased in height.

Having thus described an embodiment of this invention it should be evident to those skilled in the art that many changes and modifications may be made therein without departing from its spirit or scope as defined by the appended claims.

I claim:

1. The steps in the process of impregnating fibrous material, which comprise passing the material through hot saturant at atmospheric pressure and then subjecting the material to vacuum conditions out of the saturant.

2. The steps in the process of impregnating fibrous material, which comprise coating the entire surface of the material at atmospheric pressure with saturant and then subjecting the coated material to vacuum conditions.

3. The steps in the process of impregnating fibrous material, which comprise passing the material through hot saturant at atmospheric pressure and then subjecting the material alternately to vacuum conditions out of the saturant and pressure conditions in the saturant.

4. The steps in the process of impregnating fibrous material, which comprise passing the material through hot saturant at atmospheric pressure, subjecting the material to vacuum conditions out of the saturant, and then passing it into the saturant and forcing the saturant thereinto.

5. The process of impregnating fibrous material, which comprises passing the material through hot saturant, forcing hot saturant into the material in the course of its passage therethrough by pressure greater than the hydrostatic head of the saturant about it so as to heat it below its surface, and then subjecting it to vacuum conditions to draw therefrom air and the vapors produced by such heating.

6. The process of impregnating fibrous material which comprises alternately forcing hot saturant into the material as it passes through the saturant by pressure greater than the hydrostatic head of the saturant so as to heat the material below its surface, and then subjecting it to vacuum conditions to draw therefrom air and the vapors produced by such heating.

7. An apparatus of the class described comprising a tank, a chamber normally in communication through a narrow throat with said tank, said tank and chamber being constructed to contain saturant above the level of said throat and under a pressure within said chamber different from the pressure in said tank, and means for passing fibrous material through the saturant in said tank, through and substantially filling said throat and through and above the saturant within said chamber.

8. An apparatus of the class described comprising a tank, a chamber normally in communication through a narrow throat with said tank, said tank and chamber being constructed to contain saturant above the level of said throat and under a pressure within said chamber different from the pressure in said tank, means for passing fibrous material through the saturant in said tank, through said throat and through and above the saturant within said chamber, and means for so relating the various parts of the apparatus so that a length of fibrous material may be threaded therethrough entirely above the level of the saturant.

9. An apparatus of the class described comprising a tank, a closed chamber, said tank and chamber being constructed to contain saturant, means for maintaining a different pressure on the saturant in said chamber from

that in said tank, and means for passing fibrous material to be saturated into the saturant in said tank, into said chamber beneath and above the surface of the saturant therein, and out through the saturant in said tank.

10. An apparatus of the class described comprising a tank, a closed chamber, said tank and chamber being constructed to contain saturant under different pressures, means for passing material to be saturated into the saturant in said tank, into said chamber beneath and above the surface of the saturant therein, and out through the saturant in said tank, and means for so relating the parts of the apparatus that the material to be saturated may be threaded therethrough entirely above the level of the saturant.

11. An apparatus of the class described comprising a tank, a closed chamber, said tank and chamber being constructed to contain saturant under different pressures, means for passing material to be saturated into the saturant in said tank, into said chamber beneath and above the surface of the saturant therein, and out through the saturant in said tank, and means for so relating the parts of the apparatus that the material to be saturated may be threaded therethrough in a straight path entirely above the level of the saturant.

12. An apparatus of the class described comprising a tank, a chamber in said tank, said chamber having a pair of oppositely disposed openings through the side thereof, said tank and chamber being constructed to contain saturant at a level intermediate the upper and lower edges of said openings, gates movable to substantially close said openings leaving a narrow throat below each gate and the lower end of each opening for the passage of material to be saturated, means to feed the material through said chamber, guides for leading the material above and below the level of saturant in said chamber, and means for producing a vacuum in said chamber above the saturant.

13. An apparatus of the class described comprising a tank, a chamber in said tank, said chamber having a pair of oppositely disposed openings through the side thereof, said tank and chamber being constructed to contain saturant at a level intermediate the upper and lower edges of said openings, gates vertically slidable to substantially close said openings, leaving a narrow throat below each gate and the lower end of each opening for the passage of material to be saturated, means to feed the material through said chamber, guides for leading the material above and below the level of saturant in said chamber, and means for producing a vacuum in said chamber above the saturant.

14. An apparatus of the class described comprising a tank, a chamber in said tank, said chamber having a pair of oppositely disposed openings through the side thereof, said tank and chamber being constructed to contain saturant at a level intermediate the upper and lower edges of said openings, gates vertically slidable to substantially close said openings leaving a narrow throat below each gate and the lower end of each opening for the passage of material to be saturated, means to feed the material through said chamber, guides for leading the material above and below the level of saturant in said chamber, means for producing a vacuum in said chamber above the saturant, and means for raising said gates above the level of the saturant and so relatively disposing said feeding means and guides as to permit the threading of the material through said chamber entirely above the saturant.

15. An apparatus of the class described comprising a tank, a chamber in said tank, said chamber having a pair of oppositely disposed openings through the side thereof, said tank and chamber being constructed to contain saturant at a level intermediate the upper and lower edges of said openings, gates vertically slidable to substantially close said openings leaving a narrow throat below each gate and the lower end of each opening for the passage of material to be saturated, means to feed the material through said chamber, guides for leading the material above and below the level of saturant in said chamber, means for producing a vacuum in said chamber above the saturant, and means for raising said gates above the level of the saturant and so relatively disposing said feeding means and guides as to permit the threading of the material through said chamber in a straight path entirely above the saturant.

16. An apparatus of the class described comprising a tank for containing saturant, a chamber for containing saturant under a different pressure than in said tank, means for leading material to be saturated between said tank and chamber comprising squeeze rolls submerged in the saturant, means in said chamber for leading the material out of the saturant, and squeeze rolls submerged in the saturant in said chamber between which the material passes intermediate said leading means.

17. An apparatus of the class described comprising a tank for containing saturant, a chamber for containing saturant, means for leading material to be saturated between said tank and chamber comprising squeeze rolls submerged in the saturant, means in said chamber for leading the material out of the saturant, squeeze rolls submerged in the saturant in said chamber between which the material passes intermediate said leading means, and means for producing a vacuum in said chamber above the saturant.

18. An apparatus of the class described comprising a tank for containing saturant,

a chamber for containing saturant, means for leading material to be saturated between said tank and chamber comprising squeeze rolls submerged in the saturant, means in said chamber for leading the material out of the saturant, squeeze rolls submerged in the saturant in said chamber between which the material passes intermediate said leading means, means for producing a vacuum in said chamber above the saturant, and means for heating the saturant.

19. An apparatus of the class described comprising a tank for containing saturant, a chamber for containing saturant seated in and rising above said tank and having oppositely disposed openings extending above and below the level of saturant in said tank, vertically slidable gates for said openings, a lower feed roll at the lower end of each opening submerged in the saturant, an upper feed roll carried by the lower end of each gate to cooperate when the gate is lowered with the corresponding lower feed roll, a lower feed roll within the chamber and also submerged within the saturant, an upper feed roll vertically movable into and out of cooperating relation to said chamber lower feed roll, guides vertically movable above the level of saturant in said chamber between said chamber roll and gate rolls, and means for raising said gates and upper chamber roll and for lowering said guides so that the material to be saturated may be threaded between the upper and lower feed rolls through said chamber and over said guides in a straight path above the level of the saturant, and for thereafter raising said guides and lowering said gates and upper chamber roll into cooperative relation to said lower feed rolls, to submerge the material in the saturant in said tank and to alternately submerge and raise above the saturant the material in said chamber.

20. An apparatus of the class described comprising a tank for containing saturant, a chamber for containing saturant seated in and rising above said tank and having oppositely disposed openings extending above and below the level of saturant in said tank, vertically slidable gates for said openings, a lower feed roll at the lower end of each opening submerged in the saturant, an upper feed roll carried by the lower end of each gate to cooperate when the gate is lowered with the corresponding lower feed roll, a lower feed roll within the chamber and also submerged within the saturant, an upper feed roll vertically movable into and out of cooperating relation to said chamber lower feed roll, guides vertically movable above the level of saturant in said chamber between said chamber roll and gate rolls, means for raising said gates and upper chamber roll and lowering said guides so that the material to be saturated may be threaded between the upper and lower feed rolls through said chamber and over said guides in a straight path above the level of the saturant, and thereafter raising said guides and lowering said gates and upper chamber roll into cooperative relation to said lower feed rolls to submerge the material in the saturant in said tank and to alternately submerge and raise above the saturant the material in said chamber, means for driving said lower feed rolls, and means for driving said upper feed rolls from said lower feed rolls when they are in cooperative relation therewith.

21. An apparatus of the class described comprising a tank and a chamber each constructed to contain saturant, means for feeding material to be saturated through saturant in said tank and through saturant in said chamber, means for producing a different pressure on the saturant in said chamber than in said tank, and means for maintaining the saturant in said chamber at a predetermined level different from the hydrostatic head of the saturant corresponding to the pressure difference in said tank and chamber.

22. An apparatus of the class described comprising a tank and a chamber each constructed to contain saturant, means for feeding material to be saturated through the saturant in said tank and chamber, means for producing a vacuum in said chamber above the saturant, and means for maintaining the level of saturant in said chamber at a height above that of the saturant in said tank less than the hydrostatic head corresponding to the amount of vacuum.

23. An apparatus of the class described comprising a tank, a chamber in said tank, said tank and chamber being constructed to contain saturant, means for feeding material to be saturated through the saturant in said tank and chamber, means for producing a vacuum in said chamber, and an overflow tank adapted to be put in communication with said tank or chamber at will and arranged to prevent the raising of the level of saturant in said chamber from leakage from said tank to a height above that of saturant in the tank equal to the hydrostatic head corresponding to the difference in pressure on the saturant in said tank and chamber.

24. An apparatus of the class described comprising a tank, a closed chamber, said tank and chamber being constructed to contain saturant under different pressures, and means movable to permit sheet material to be threaded through the apparatus in a substantially straight path above the level of the saturant and then to immerse the material in the saturant.

25. An apparatus of the class described comprising a chamber for containing saturant under pressure other than atmospheric, and means movable to permit sheet material

to be threaded through said chamber in a straight path above the level of saturant therein and then to immerse the material in the saturant.

26. The steps in the process of impregnating fibrous sheet material which comprise coating opposite faces of the material at atmospheric pressure with the saturant and then subjecting the coated material to vacuum conditions.

27. The process of impregnating fibrous sheet material which comprises forcing hot saturant into the material from both faces as to heat it below its surface, and then subjecting it to vacuum conditions to draw therefrom air and the vapors produced by said heating.

28. An apparatus of the class described comprising a chamber for containing saturant, means for leading sheet material through said chamber passed beneath and above the level of the saturant therein and in complete surface contact with the saturant, means for forcing saturant into the material when submerged by pressure greater than the hydrostatic head of the saturant, and means for establishing vacuum conditions in said chamber.

29. The process of impregnating fibrous material, which comprises submerging the material in hot saturant, squeezing the material while so submerged so as to force saturant into the material over its entire surface, and then subjecting the material to vacuum conditions to draw therefrom air and the vapors produced by the heating effect of the saturant.

In testimony whereof I have affixed my signature.

ROBERT T. JOHNSTON.