June 8, 1926. 1,587,652

R. T. JOHNSTON

METHOD OF AND APPARATUS FOR IMPREGNATING FELT WITH BITUMINOUS MATERIALS

Filed Feb. 17, 1921 4 Sheets-Sheet 1

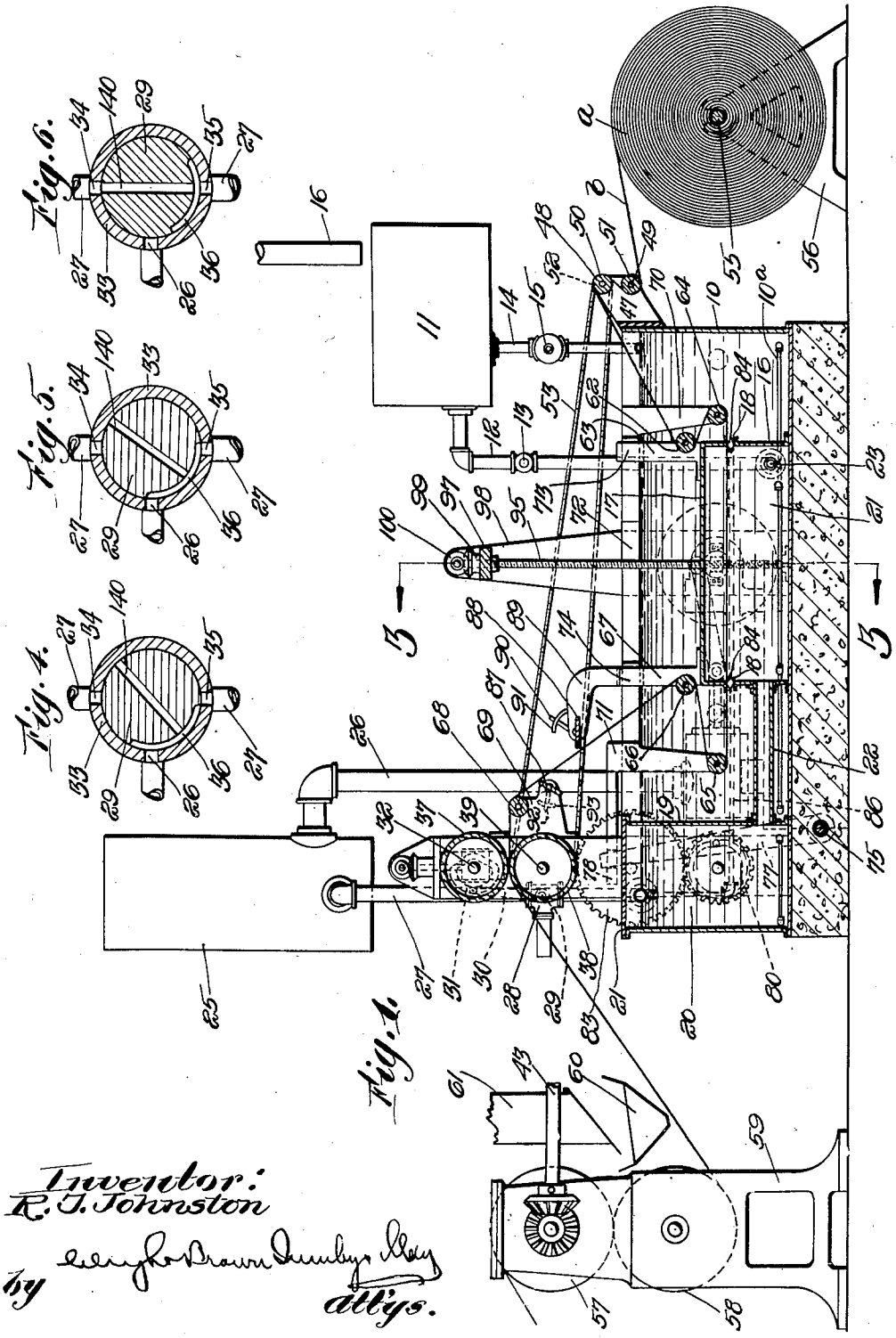


Fig. 1.

Fig. 6.

Fig. 5.

Fig. 4.

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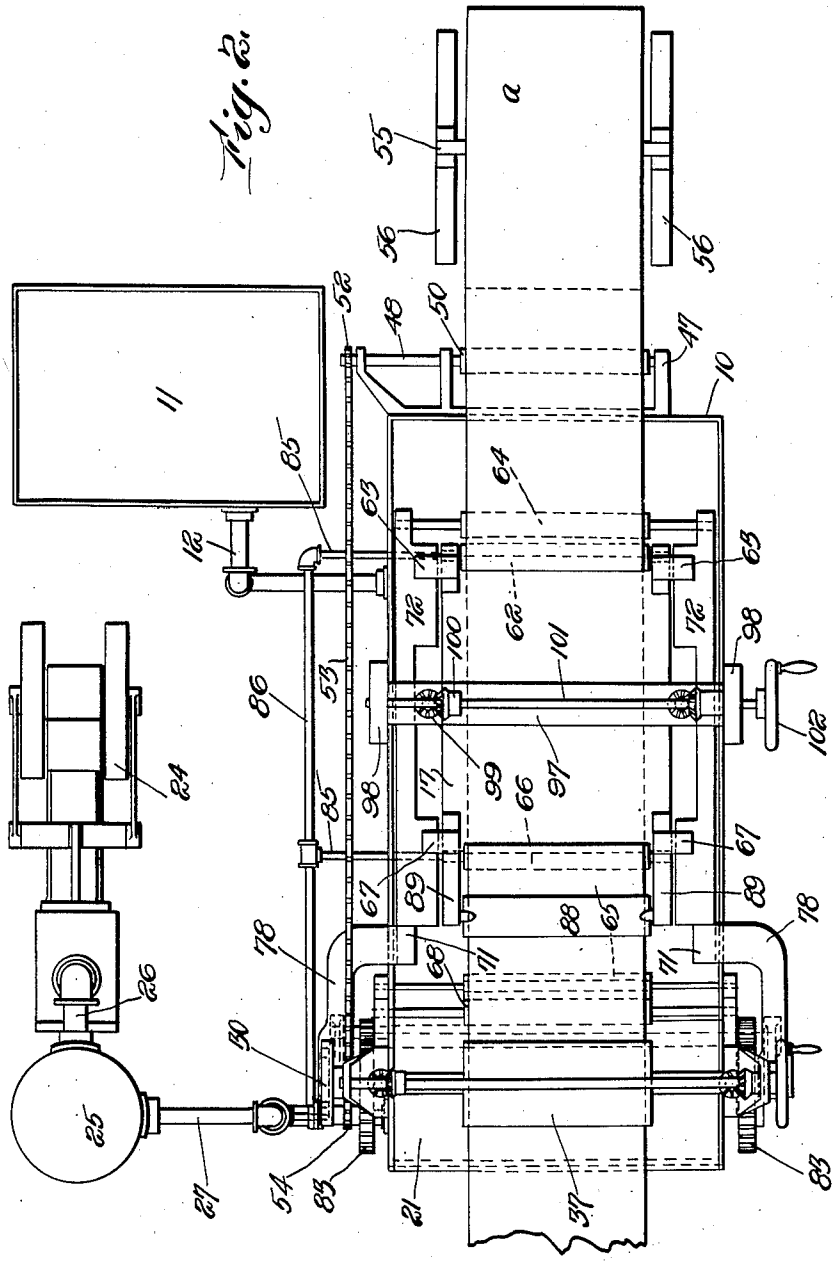
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Fig. 2.



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Fig. 3.

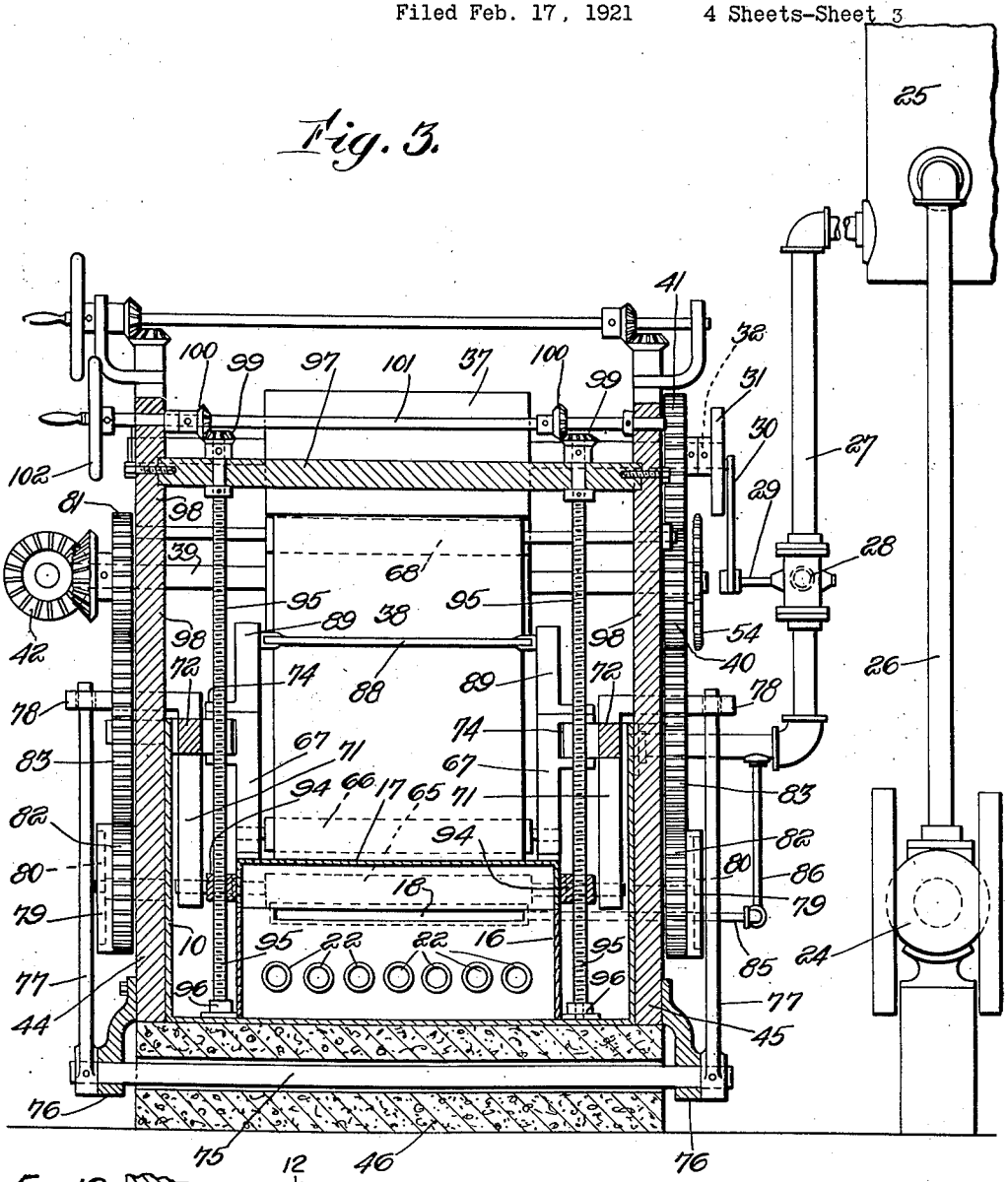


FIG. 12.

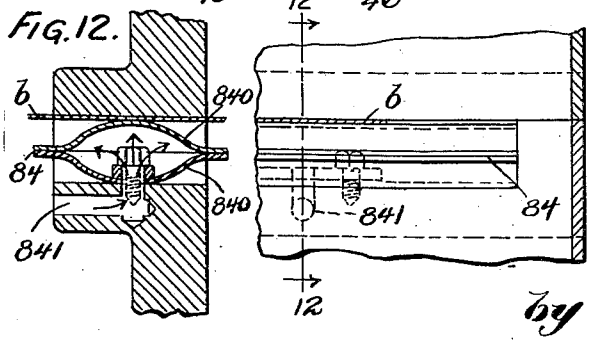
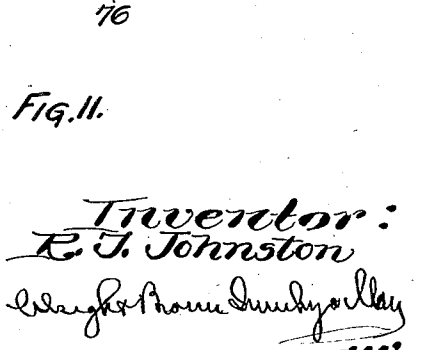


FIG. 11.



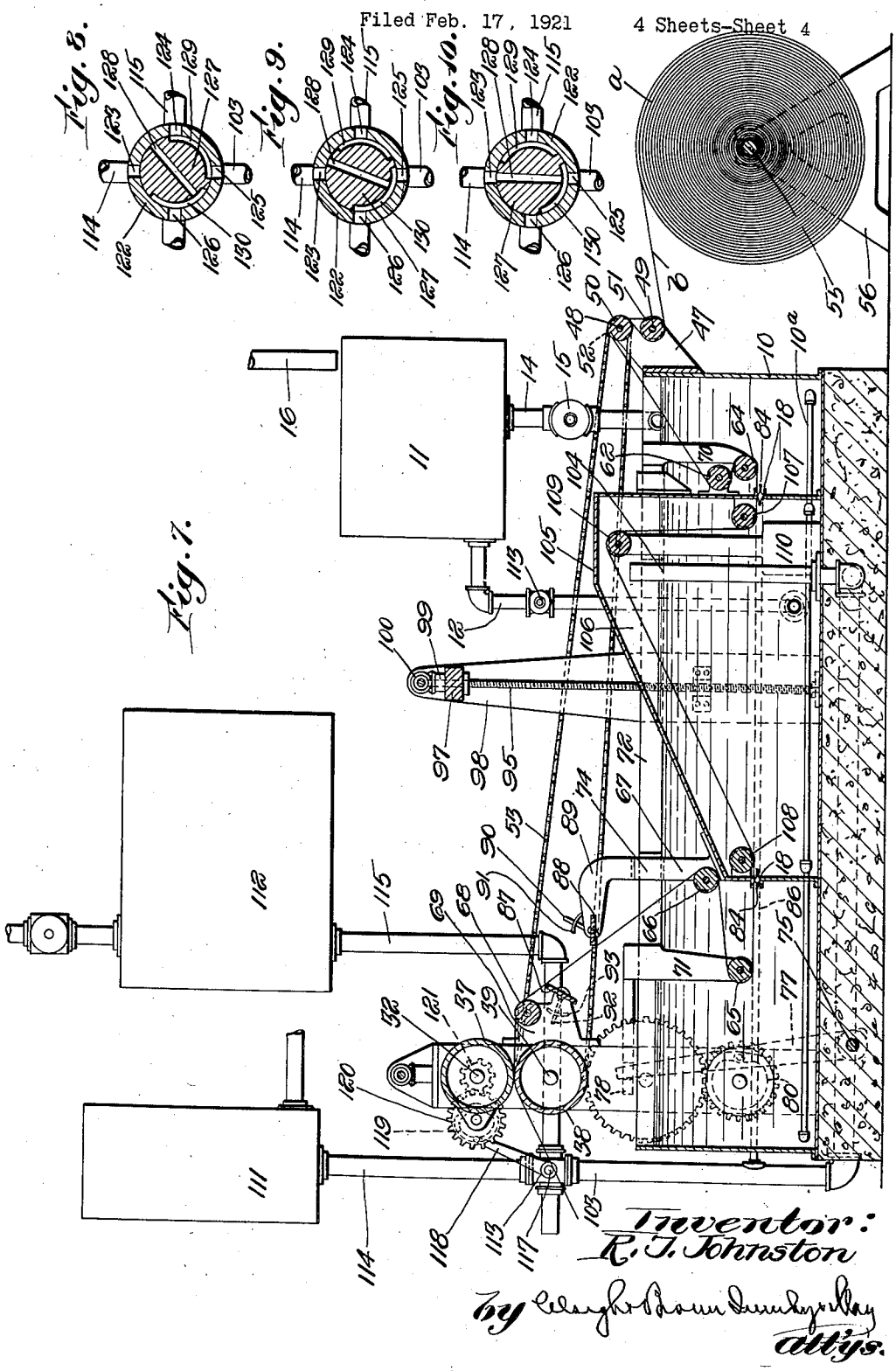
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METHOD OF AND APPARATUS FOR IMPREGNATING FELT WITH BITUMINOUS MATERIALS

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Patented June 8, 1926. 1,587,652

UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR IMPREGNATING FELT WITH BITUMINOUS MATERIALS.

Application filed February 17, 1921. Serial No. 445,877.

This invention relates to the impregnation or saturation of fibrous materials with pitch, tar, asphalt or other hydrocarbon or bituminous compounds, but more especially relates to the saturation of raw felt with such compounds in the manufacture of prepared roofing or flooring materials. It has been the universal commercial practice, after the raw felt has been formed in a sheet of indeterminate length on a paper making machine, to pass the sheet slowly through a bath of bituminous or hydrocarbon compound having a relatively low melting point, to permit the molten material to penetrate the voids or interstices of the felt, then, depending upon the use to which the thus saturated felt is to be employed, that is whether for flooring or roofing purposes, the sheet in the one case after being cooled is wound into rolls, and in the other case it is coated with a relatively thick coating of a bituminous compound having a relatively high melting point, and in some instances, while this coating is relatively soft and plastic, a surface layer of crushed slate or other crushed mineral material is more or less embedded therein.

The extent to which the felt is saturated by the processes thus briefly referred to depends upon at least three factors, namely, the porosity of the sheet, the fluidity or viscosity of the bituminous or hydrocarbon compound and the speed at which the felt is caused to travel through the bath.

It has heretofore been regarded as impractical to use for the saturating compound an asphalt or pitch having a relatively high melting point for the reason that to so condition the asphalt as a fluid so as to enable it to penetrate the sheet, the asphalt must be heated to a relatively high temperature. This has been a serious obstacle in the impregnation of the sheet for the reason that to permit the impregnation the sheet had to travel for a considerable period of time while in contact with the asphalt and the temperature to which the asphalt was subjected had the effect of charring or injuring the fibers of the sheet and thus destroying the integrity of the sheet. For this reason therefore it has been the uniform practice to employ as a saturating or impregnating compound an asphaltic or bituminous material having a low melting point. Consequently such sheets when exposed to solar heat, particularly in the southern climates, soften and there is a tendency for the exudation of the saturating compound. But even under the most favorable conditions the method of impregnating the raw felt, even with an asphaltic compound of low melting point, has not been effective in completely saturating the material. This is evidenced by the fact that when the sheet is cut into shingles or strips and such strips have been laid on the roof, the shingles tend to curl at their corners, due to the fact doubtless that because of the imperfect impregnation water is absorbed by the fibers. It has been generally recognized that the extent to which felt may be saturated under the conditions mentioned, in which the sheet is passed through a bath of relatively low melting point asphalt at atmospheric pressure does not exceed 78%. Again in accordance with previous practice it is essential that the sheet should be highly absorbent but the absorbent qualities of the sheet were limited by the necessity of imparting to the sheet requisite strength with which to stand the tensile strains to which it is subjected by the saturating, coating and subsequent operations.

Broadly stated the object of the present invention is to provide a process by which the felt may be more completely and effectively saturated than heretofore and an apparatus by which the process may be carried out, and a further object of the invention is to provide such a process and apparatus that it is possible to employ as a saturating compound, an asphaltic material having a relatively high melting point, for example, blown asphalt which has heretofore been used only for the purpose of skin coating the already saturated sheet. The process by which I accomplish these objects includes the saturation of the sheet under pressure greater than atmospheric pressure, by which the asphalt is caused to penetrate the voids, pores and interstices of the sheet and effectively coat the individual fibers of which the sheet is composed, and it also includes the saturation and coating of the felt by a single operation, in which the same compound which is employed for coating the felt is

utilized in saturating it. In this way I am able to avoid the use of different saturating and coating compounds and am able to produce a sheet which is not affected by solar heat and in which the fibers at the severed edges of the sheet will not absorb moisture when exposed to the elements.

Generally speaking to accomplish the objects thus noted, I employ a vat or saturating tank which is capable of receiving a charge of asphalt or its equivalent and in which the latter may be maintained at the desired high temperature in a molten condition and mechanism by which the asphalt may be subjected to relatively high pressure while the felt is immersed therein so that the asphalt may be absorbed to a much greater extent by the felt than has heretofore been possible. By saturating the sheet under pressure I am able to decrease the period of time which has heretofore been required for the immersion of the felt in the molten bath so that a high melting point asphaltum may be used for the saturating compound without injury to the felt due to the prolonged period of immersion.

The raw felt, as heretofore stated, is produced in long sheets usually upon a paper machine and is wound into rolls, each roll containing a sheet hundreds of feet in length. In accordance with the processes which I shall hereinafter describe in detail, successive portions of the sheet are subjected to the saturating operation, that is to say the sheet is advanced through the saturating tank so that only a portion thereof is being treated at any one time. It is desirable that the sheet of felt should be fed to and withdrawn from the saturating tank with a continuous motion so that the saturated sheet may be delivered to continuously operating mechanisms which perform operations upon the sheet.

In explanation I may say that after a sheet, designed for use as a roofing material, has been saturated and impregnated, it is customary to apply the surface layer of crushed slate or other mineral grit thereto, subject it to a cooling operation and then cut it into shingles or strips or to wind it in a roll as the case may be. All of these instrumentalities are usually operated at a continuous speed so that it is desirable that the feed of the sheet to such instrumentalities should not be interrupted or intermittent. In the saturating mechanism which I have illustrated as constituting the embodiment of the invention, and by which the sheet is subjected to what I may term pressure saturation, provision is made for feeding successive portions of the sheet to that portion of the apparatus in which the asphalt is forced by pressure into the sheet, wherein said portions remain quiescent or at rest for short periods of time, and also provision is made for taking up and letting out portions of the sheet in advance and in the rear of the saturating chamber so as not to interfere with the continuous motion of the remainder of the sheet. In such apparatus I also provide not only for the saturation of the sheet under pressure but also for its subsequent coating by material possessing the same characteristics as those which mark the saturating compound.

Proceeding to a more detailed description of the apparatus which I have illustrated as constituting one embodiment of the invention:—

Fig. 1 illustrates partially in longitudinal section a saturating and coating apparatus by which my process may be practiced.

Fig. 2 represents a plan view of same.

Fig. 3 represents a transverse section on line 3—3 Fig. 1.

Figs. 4, 5, 6, represent sections through a controlling valve which governs the pressure in the pressure saturating chamber.

Fig. 7 represents in longitudinal section another form of apparatus embodying the invention which may be used in carrying out my processes.

Figs. 8–10 inclusive represent sections through an automatic valve utilized in connection with this machine.

Figure 11 is a detail of a restricted throat showing a valve therein.

Figure 12 is a detail section on line 12—12 of Figure 11.

Before I proceed to describe in detail the apparatus illustrated on the drawings thus briefly referred to and to explain my processes, I desire to call attention to the fact that the drawings are more or less conventional or diagrammatic, that the phraseology herein employed is for the purpose of description and not of limitation and that various changes may be made both in the process and in the apparatus without departing from the spirit and scope of the invention as set forth in the appended claims.

On the drawings, now having particular reference to Figs. 1 to 6 inclusive, I have shown a tank 10 of any suitable form and made of any suitable materials, adapted to receive the body of molten asphalt. Preferably I employ what is known as blown asphalt which has an approximate melting point of 220° F., such asphalt when cold having a more or less rubbery consistency and being particularly desirable for use in connection with prepared roofings and floorings. Any suitable means may be employed for heating the body of asphalt in the tank 10 so as to maintain it at a desired temperature such, for example, as a temperature of 400°–420° F. I have indicated conventionally at 10^a steam heating coils for this purpose. At 11 I have shown an auxiliary receptacle in which the asphalt is stored in

a molten or fluid condition and in which it may be maintained at the desired temperature by any suitable heating devices not shown. From this auxiliary tank the asphalt may flow by gravity through a pipe 12 to the tank, a check valve 13 being provided in the pipe to control the flow of asphalt thereto and to prevent its return under pressure to the tank 11. For the purpose of maintaining the asphalt in the tank at a constant level, I employ a return pipe 14 equipped with a pump 15. The inlet to the pipe 14 which communicates with the tank 10 is located at the desired level of the body of asphalt. It will be seen that I have provided a circulating system by which the asphalt may be continuously supplied to the tank and returned to the auxiliary tank for re-heating and by which the level of the body of asphalt in the tank 10 may be maintained at a constant level. The asphalt may be delivered to the auxiliary tank from the initial vat in which the asphalt is primarily melted, through a spout 11a. Within the tank 10 is located a casing comprising a main body portion 16 and a cover 17 which forms a pressure chamber submerged below the level of the asphalt in the tank 10. This pressure saturating chamber is closed except for narrow throats or slots indicated at 18—18 at its ends through which the sheet may be passed into and out of the chamber as will be subsequently explained. It is sufficient to state at this time that these throats may be closed by valves of suitable character so that the contents of the pressure saturating chamber may be subjected to high pressure without any material escape of asphalt. The casing constituting the pressure chamber is of sufficient width to receive the widest sheet which it may be desired to saturate. Near one end of the tank is an upright partition 19 which, together with the attached end wall of the tank 10, forms a compartment 20 which is closed by a cover plate 21. These parts thus far described may be made of metallic sheets or plates, the tank 10 being, if desired, substantially oblong in plan view and open to the atmosphere except for the compartment 20. A series of pipes 22 connect the compartment 20 with the pressure chamber 20a formed by the casing 16 and its cover 17, to allow a free flow of asphalt back and forth between the said compartment and said pressure chamber. Instead of feeding the asphalt from the reservoir or supply tank 11 merely to the tank 10, I prefer to carry the end of the pipe 12 to a point where it delivers asphalt directly into the pressure chamber as indicated at 23.

By mechanism subsequently to be described the sheet of raw felt is fed step by step or intermittently through the pressure chamber 20a and while therein the asphalt in said chamber is subjected to great pressure to force it into the felt. This increased pressure may be obtained or secured in any one of many different ways. For example, I have illustrated conventionally at 24 an air pump by which air is pumped under high pressure into an air reservoir or storage tank 25 through a pipe 26. The pipe 27 leads from the air storage tank 25 into the compartment 20 which it enters through the side wall of the main tank 10 at a point near or above the level of the asphalt therein. Thus the asphalt in compartment 20 may be subjected to great pressure,—I may say pressure of 60 lbs. to the square inch,—as a result of which, by reason of the connecting conduits or pipes 22, the asphalt in the pressure chamber 20a may be subjected to like pressure in all directions. Pipe 27 is provided with a valve 28 which is automatically operated to deliver air to and cut it off from the compartment 20. Any suitable valve or mechanisms therefor may be used for this purpose. The valve stem which is indicated at 29 may be provided with a lever 30 having at its free end a roll or truck projecting into a cam groove in a cam 31 mounted upon a shaft 32 which is continuously operated as will be subsequently explained. The cam is so formed that during each rotation of the shaft 32 the valve is opened for about one-third of the revolution of the shaft and is closed during the remainder of the rotation of the shaft. In Figs. 4 to 6 inclusive I have illustrated a type of valve which may be utilized for this purpose, these figures representing transverse sections through the valve. The valve body or casing 33 is provided with the inlet and outlet ports 34, 35 which communicate with sections of the pipe 27. It is also provided with an exhaust port 28. The rotary valve member 29 has a passage way or aperture 140, which, when it is in position shown in Fig. 6 establishes direct communication through the pipe 27 to the compartment 20 to admit the air thereto. When valve member 29 is moved into the position shown in Fig. 5, the passage of air is cut off and the pressure is removed from the compartment 20 through the exhaust port 28 by a peripheral passage way or groove 36 in the valve member 29 which communicates with the port 35. When the valve member 29 however reaches the position shown in Fig. 4, both the ports 34 and 35 are closed. The valve member 29 is oscillated by the cam operating lever automatically so as to establish communication between the air reservoir 25 and the compartment 20, during the period of time that a portion of the sheet of felt is at rest in the pressure saturating chamber, to cut off the supply of air to said compartment and permit the removal

of pressure therein, and finally to close the chamber 20 to the atmosphere through the exhaust, this occurring during each oscillation of the valve member as explained. The period of time in which the pressure in tank 20 is released is very small, and when the valve member comes to a state of rest in its closed position as in Fig. 4, the air under atmospheric pressure in compartment 20 is trapped to prevent the asphalt from forcing its way up into the pipe 27. Above the compartment 20 may be located two rolls 37, 38 for regulating the thickness of the coating which is applied to the saturated sheet as will be explained. These two rolls are positively driven. The shaft 39 for roll 38 is timed in reference to the instrumentality which subsequently operates the sheet so that the peripheral speed of the roll 38 is equal to the desired speed of travel of the sheet of felt and is equal to the peripheral speeds of the other rolls in the other instrumentalities which operate on the sheet. The shaft 39 has at one end a gear 40 which intermeshes with and drives a gear 41 on the shaft 32 which is also utilized for the roll 37. It will be recalled that this shaft 32 is the one to which the cam 31 is secured. The shaft 39 is further utilized in driving other mechanisms which I will subsequently explain and which may also be driven by means of a bevel gear 42 on shaft 43 which may be referred to as the prime power shaft from which the various instrumentalities employed in connection with the felt are driven. The shafts 32 and 39 are mounted in upright standards 44, 45 between which the tank 10 is located as shown in Fig. 3. I may here state that the tank and the uprights or frame members 45 may be supported by a bed 46 of any suitable material, such as concrete, or the like.

I prefer that the sheet shall be positively fed to the tank, and for this purpose, at the end of the tank opposite that over which the rolls 37, 38 are located, I provide suitable brackets 47 in which are journalled the shafts 48, 49 for rolls 50, 51 around which the web of felt may be passed as will be explained. The shaft 48 is driven in timed relation to the roll 38 and for this purpose it may be provided with a sprocket wheel 52 connected by sprocket chain 53 with a sprocket wheel 54 on the shaft 39. The parts are so related that the peripheral speed of the feed roll 48 is equal to that of the roll 38. The roll of felt which is to be saturated and which is indicated at *a* has its beam 55 journalled in a suitable stand indicated at 56. After the felt has been drawn from the roll and passed through the saturating and coating compound and has been delivered over the roll 38, it may be passed to a reeling or winding mechanism if it is to be used for the manufacture of flooring, but, if it is to be employed for roofing purposes, it may then be passed to cooling drums 57, 58 which are journalled in a frame indicated as a whole at 59. It is frequently desirable to apply to the sheet a surface layer of crushed slate or other suitable comminuted mineral material and consequently I have indicated conventionally at 60 a hopper or trough from which such material shall be showered on the surface of the felt prior to its passage under the roll 58 and around the roll 57. The comminuted mineral material may be supplied to the trough through a conduit indicated at 61. As the sheet passes around and between the cooling drums 57, 58, the slate or other mineral particles are more or less embedded in the plastic coating so as to form a surface layer which covers and conceals the asphaltic coating in which they are embedded.

The shaft for the roll 57 may be geared to the shaft 43 by any suitable form of gearing such as bevel gears so that its peripheral speed is equal to the roll 38.

I will now describe the apparatus by which the sheet as a whole is fed continuously and by which successive lengths of the felt are brought to a state of rest in the pressure saturating chamber 21 and subjected to pressure saturation without interfering with the continuous or unvarying feed of the remainder of the sheet.

For this purpose a looper or take-up mechanism is utilized which gradually takes up and lets out the sheet of felt during the interval of time in which a portion of the felt is at rest within the pressure saturating chamber. As illustrated in the drawings, the sheet of felt *b* from the roll A passes under and over the feeding and guide rolls 51, 50 which feed it into the tank 10. Thence the sheet passes downwardly into the body of asphalt and around a guide roll 62 which is loosely journalled in up-standing bars 63 attached to the cover section 17 of the pressure saturating chamber. Thence the sheet is passed around the take-up roll 64, thence through the entrance throat 18 into the pressure saturating chamber 21, then out through the delivery throat 18 to take-up roll 65. From the take-up roll 65 the sheet passes to a roll 66 similar to that at 62 and journalled loosely in up-standing bars 67 which, like those at 63, are affixed to the cover section 17. From the roll 66 the sheet passes to a guide roll 68 which is journalled loosely in brackets 69 attached to the upstanding frame bars 44, 45 in which the shafts for the rolls 37, 38 are journalled. The rolls 66, 62 are journalled in relatively stationary bearings, whereas the take-up rolls 64 and 65 are movable longitudinally in the tank 10 to form and let out loops in the sheet of felt. For this purpose the rolls 64 and 65 are journalled in depending arms 70, 71

formed on slide bars 72 which are movable longitudinally in guide ways 73, 74 formed in up-standing bars 63, 67. The slide bars 72 and their depending arms 70, 71 constitute a reciprocating frame by which take-up rolls are moved bodily lengthwise of the tank. The reciprocation of the take-up frame may be effected in any such way by any suitable mechanism, but of course the reciprocation must be timed in reference to certain other instrumentalities in the apparatus; as for example the frame may be reciprocated by a mechanism comprising the rocking shaft 75 journalled in bearings formed in brackets 76 depending from the up-right frame bars 44, 45. This shaft is illustrated as passing through an aperature formed in the concrete base 46. On the ends of this rock shaft are the two arms 77, 77 the upper ends of which are engaged in slots formed in lateral extension 78 of the slide bars 72. The arms 77 are oscillated by cams 79, 79 having cam grooves 80 into which rolls or trucks on the arms 77 project. For operating these cams two trains of gears are utilized to transmit motion thereto from the drive shaft 39. There is on said shaft 39 a gear 81 like that at 50 which is on the other end of said shaft. Secured to each cam 79 there is a gear 82, these cams and gears being journalled on stud shafts affixed to the up-right frame members 44, 45. Between the gears 81 and 40 on the shaft 39 and the gears 82, 82 there are idler gears 83 journalled on stud shafts affixed to the up-right bars 44, 45 so that the cams will be rotated in timed relation to the shaft 32 which has the cam 31 controlling the operation of the air valve 28.

Assuming that a given length of felt is fed into the pressure saturating chamber 21 and that the parts are in position shown in Fig. 1—when this has been accomplished it will be seen that as the take-up frame moves to the right a loop will be formed in the length of felt between the throat 18 and the guide roll 62 by the take-up roll 64, and that, as this loop is formed in the felt, the loop previously formed by the take-up roll 65 between the outlet throat 18 and the guide roll 66 will be released in the same proportion so that the length of the sheet which is in the saturating chamber will remain at rest even though a portion of the felt is being fed continuously into the tank by the roll 50 and the length of the sheet from the roll 66 to the rolls 37, 38 is moving continuously. After the take-up frame has completed its movement to the right in Fig. 1 and has started to the left, the loop formed by the roll 64 will be given up and a loop will be formed by take-up roll 65, and this together with the normal feed of the sheet by the rolls 57, 58 in the stand 59 will cause a fresh length of the felt to be fed into the pressure chamber. The parts are all so correlated that each length of felt which is fed into the pressure saturating chamber is approximately equal to the length of that chamber.

It is desirable, as previously stated, that the throats 18 at the ends of the pressure saturating chamber should be closed at certain times when the asphalt in said chamber is subjected to great pressure. Preferably these throats are formed at the junction of the cover 17 with the main body 16 of the casing which constitutes said chamber. In these throats I locate pneumatic diaphragm valves 84, 84 over which the length of felt passes as it enters and leaves the pressure saturating chamber. These valves, as shown in Figures 11 and 12, are each composed of a pair of superposed plates 840 made fast to each other at their side edges, but free intermediate their edges, these plates extending from end to end of the throat and between which air may be forced through a port 841. They are operated automatically by air delivered thereto by small air pipes 85 leading from an air pipe 86 connected to the main air supply pipe 27 at a point between the diaphragm valve 28 and the compartment 20. Hence when the throat valve is opened to admit air to the compartment 20 air is likewise introduced into the diaphragm valves 84 to close the throats 18. While I regard the use of the diaphragm valves or their equivalent as desirable, they are not wholly necessary as the throats may be so restricted as to permit practically little asphalt to escape. In such case the small amount of asphalt which might escape when the contents of chamber 21 are subjected to pressure is immaterial and of small consequence. The parts are all so timed that the diaphragm valves 84 are ready to collapse and pressure is cut off from compartment 20 when the feed of a fresh length of the felt sheet into the pressure tank 21 is to be accomplished. As soon as the take-up frame reaches the position illustrated in Fig. 1 the main air valve 28 is automatically operated to admit air into the compartment 20, and, as previously explained, to subject the asphalt in the pressure chamber 21 to great pressure so as to force it into the pores and interstices of the felt which is in said chamber. The pressure is not cut off until the take up frame just about reaches the limit of its movement to the right, whereupon the main air valve is operated to cut off the pressure from the compartment 20, and the pressure in said compartment and the diaphragm valve 84 is released, permitting the latter to collapse, whereupon the next successive length of the sheet is fed into the tank, and, as the take-up frame completes its movement to the left, that is to the position shown in Fig. 1, the main valve is again operated to permit

the air to enter the compartment 20 and thus subject the asphalt in the pressure chamber to increased pressure.

I desire to call attention to what may be regarded as an important feature of the apparatus and of my processes and that is to the initial submergence of the felt in the bath of asphalt before it is subjected to pressure saturation. As the sheet enters the bath of asphalt, it is coated initially with asphalt and thus, when it occupies the pressure chamber and is subjected to pressure, that portion of the asphalt which initially coated the sheet is now forced into the sheet, together with additional asphalt, so as to impregnate it to a maximum extent. After the sheet leaves the pressure tank it is still submerged in the asphalt so that it receives an additional coating of the asphalt. I provide means by which the coating of asphalt may remain on the sheet after it leaves the tank. For this purpose I employ two doctors or scrapers 87, 88. These are located between the rolls 66 and 68 and are above the level of the asphalt in the tank. The scraper 87 bears against the under side of the sheet and removes the excess asphalt therefrom, which drops from the scraper blade back into the tank. The doctor or scraper 88 is arranged to engage the upper face of the saturated and coated felt so as to remove the surplus asphalt, and yet leave a skin coating thereon if desired. The doctor 88 consists of a blade which extends across the sheet and its ends are mounted in brackets 89 formed on up-standing guide bars 67. The blade may be provided with a handle 90 movable along a stationary segment 91 and attached to a clamp thereon in any position to which it may be adjusted. The doctor 87 likewise consists of a blade the ends of which are journalled in the brackets 69 previously described and it too has an operating handle 92 movable along a segment 93 to which it may be clamped. After leaving the guide roll 68 the sheet passes between the rolls 37, 38 which regulate the thickness of the face coating of asphalt on the sheet.

It is unnecessary to describe the mechanism by which the roll 37 may be adjusted toward and from the roll 38 as this is a common mechanical expedient, it being sufficient to say that mechanism is provided for effecting such adjustment. If the material is to be employed for roofing purposes, the crushed slate or other mineral grit may now be applied to the still plastic skin coating on the sheet by the hopper 60, and, as the sheet then passes around and between the rolls 57, 58, the slate or other crushed mineral material is more or less embedded in the plastic coating, and at the same time the sheet is cooled by said rolls which may be supplied with any suitable cooling medium. I have indicated the rolls 37, 38 as being hollow and it will be understood that any suitable heating means may be introduced into said rolls to maintain them at the desired temperature.

It is quite desirable that in any apparatus such as I have illustrated means may be provided whereby the sheet of felt may be initially threaded through the apparatus without danger to the workmen. I have therefore provided mechanism by which the cover section 17, the guide rolls 62, 66 and the take-up rolls 64, 65 may all be lifted above the level of the asphalt in the tank so that the operatives may pass the sheet around the several rolls prior to their submergence in the molten bath. For this purpose, to the front and rear sides of the cover section 17 of the pressure saturating tank, I secure nuts 94, 94 which are in threaded engagement with up-standing screw rods 95, 95 stepped at their lower ends in bearings 96, 96 secured to the bottom of the tank 10 between the front and rear walls thereof. The upper ends of these screw bars are journalled in a cross bar 97, the ends of which are secured to the upright frame members 98, 98 as illustrated in Fig. 3. Above the cross bar there are secured to the ends of the screw bars bevelled gears 99 which intermesh with similar bevelled gears 100 on a cross shaft 101 journalled in the uprights 98 and having on one end a hand wheel 102 by which it may be rotated and to effect the simultaneous rotation of the screw bars 95. It will be remembered that the cover section 17 has attached thereto the uprights 63, 67 in which the slides 72 of the takeup frame are mounted. Consequently when the screw bars are rotated, and by reason of the attachment of the nuts 94 to the cover section the latter is elevated, it carries with it the take-up frame so that, if the rotation of the screw bars be continued, the entire take-up frame and the cover may be elevated to a plane well above the top of the tank, that is so as to lift the cover section, the guide rolls 62 and 66 and the take-up rolls 64, 65 out of the bath of asphalt. The operator is now able, without danger, to pass the end of the sheet over and under the various guide and take-up rolls and to pass it beneath the cover section and finally deliver it to the rolls 37, 38 and the cooling drums 57, 58. Then, by operating the hand wheel 102, the parts may be all restored to their operating positions. When the cover is returned to its initial position, it is clamped against the body portion of the tank by the screw bars and the nuts which lock it in place.

While I have described the mechanism as being more particularly adapted for saturating raw felt with a bituminous, asphaltic or hydrocarbon compound, of course it will be understood by those skilled in the art

that it is capable of a great variety of uses in impregnating continuous sheets of any fibrous material with any compound with which it may be desired to saturate such sheet. Primarily, however, the machine which I have illustrated and described in detail is particularly applicable for use in the manufacture of prepared roofing as I have found by experience that it is possible to force into raw felt not only a hydrocarbon of the nature of blown asphalt having a relatively high melting point but also to cause the raw felt to absorb such asphalt in greater amounts than the felt has heretofore absorbed of a low melting point asphalt, where the felt was merely drawn through a bath of such last mentioned asphalt in a fluid state. I regard it as of decided importance that by the apparatus shown the same grade of asphalt may be utilized both for saturating and coating purposes. Where the saturating compound has a relatively low melting point and the coating compound has a high melting point, it has been found in practice that the two do not amalgamate or coalesce satisfactorily and slippage occurs between them. For this reason it has been necessary heretofore to subject the saturated sheet to considerable pressure to squeeze the saturating compound more or less therefrom and leave a rough comparatively dry surface to which the asphalt employed for coating purposes can be caused to adhere.

A further advantage of my machine is that it is possible to operate it at high speed and thus diminish the period of time during which the felt is immersed in the bath of molten asphalt. Consequently it is possible to heat the asphalt to higher temperature than heretofore and thus in a measure decrease the viscosity or increase its fluidity. As the machine is herein illustrated, the sheet is first subjected to ordinary immersion in the asphalt and is then subjected to what I may term a super-saturation, after which it is again coated under atmospheric pressure and is to all intents and purposes completely saturated and rendered thereby waterproof.

In Fig. 7 I have illustrated a somewhat different embodiment of the invention by which I am able to secure an increased length of fabric in the pressure saturating chamber by forming the web in a loop in said chamber. In addition, by this embodiment of the invention, I am able to subject each successive length of the web to reduced as well as to increased pressure as will be explained. In this case, instead of providing the main tank 10 with a compartment such as at 20 in Fig. 1, the main air conduit 103 is carried beneath the main saturating tank and is connected to an upright stand pipe 104 which enters the pressure saturating chamber and terminates at a point above the level of the asphalt therein so that the air under pressure is delivered directly to the upper portion of the saturating chamber above the level of the asphalt therein. In this case the upper or cover section 105 of the chamber 106 is vertically movable and is provided with internal guide rolls 107, 108. There is also another guide roll 109 which is journalled at the upper ends of uprights 110 which are located within the pressure chamber, so that said roll 109 is above the level of the asphalt therein. The main tank is provided with the reciprocating take-up frame and take-up rolls similar to those described in connection with the machine in Fig. 1. As the felt passes from the roll 107 around the roll 109 and thence under the roll 108, a portion of the felt between rolls 107 and 108 is submerged in the asphalt and the remainder thereof is located above the asphalt. The feed of the felt through the pressure saturating chamber is such that successive lengths are first subjected to pressure while immersed in the asphalt therein and are then subjected to atmospheric pressure but preferably to reduced pressure or vacuum and are then again subjected to pressure while immersed in the asphalt. A high pressure tank for air is indicated at 111 into which air is forced by compression such as illustrated in connection with the machine in Figs. 1 to 3 inclusive. At 112 is indicated a vacuum tank from which the air is exhausted by any suitable form of vacuum pump not shown. The two tanks 111 and 112 are connected to automatic valve 113 by the pipes 114, 115. The valve member on the valve stem 117 may be constructed as illustrated in Figs. 8 to 10 inclusive. Before describing the precise construction of this valve, however, I may point out that there is attached to the valve stem a lever 118 having at its upper end a roll or truck entering a cam groove 119 in a face cam which is secured to a gear 120 intermeshing with and driven by a relatively small pinion 121 on the shaft of roll 37 so that the lever 118 is moved forward and back for each two rotations of the roll 37 and each two movements of the take-up frame. Of course any suitable valve mechanism may be utilized which will connect the pipe 103 alternately with the pressure and vacuum tanks 111, 112. The valve body or casing 122 has the ports 123, 124, 125 communicating with the pipes 114, 115, 103 respectively. There is an additional port 126 which communicates with the atmosphere. The valve member 127 connected to the stem 117 is provided with a transverse passage way 128 and also with the peripheral grooves or passage ways 129, 130. In the position of the members illustrated in Fig. 10, air is passing through the port 123, the passage way 128 and passage way 130 and through the port 125 to the pipe 103 so that

it may enter the pressure saturating chamber. In Fig. 8 the parts are so adjusted that the pressure chamber is connected with the vacuum tank and in Fig. 9 the parts are shown in the immediate position in which air trapped in the pressure saturating chamber may exhaust through the port 126 or enter the port 126 in case there is a vacuum in the pressure saturating chamber.

In operation the felt first passes into the molten bath of asphalt in the tank 10 under atmospheric pressure, and then, as it passes through what I have termed the pressure saturating chamber, each successive portion of the felt is first subjected to saturation under heavy pressure, then when it is in the upper part of the chamber it is subjected to a vacuum which has the effect of withdrawing from the felt any air and moisture that may remain therein, and then the sheet is again subjected to saturation under great pressure, after which, on leaving the chamber, it is coated as previously described.

The operation of the take-up mechanism is similar to that previously described, successive lengths of the sheet being drawn into the pressure saturating chamber and remaining quiescent therein for intervals of time, while the remainder of the sheet is being fed continuously and without interruption.

In addition to the advantages possessed by the method and apparatus as herein described, I may point out that the sheet is positively fed to and from the saturating apparatus so that there is no drag on any great length of felt. Consequently I am able to utilize a felt possessing less tensile strength than has heretofore been regarded as necessary. This enables me to employ a sheet of greater porosity and of greater caliper. Moreover the speed of the machine may be exactly correlated to the other instrumentalities which operate upon the sheet, since the feeding-in rolls are positively driven and are timed in relation to such instrumentalities. In both forms of the machine herein illustrated, the entire surface of the sheet of felt is exposed to asphalt in a chamber under great pressure by which it may be forced to penetrate the sheet from face to face, and in both cases the sheet of felt thus treated is coated and sealed with the asphalt previous to its pressure impregnation and again coated after its impregnation. Again in both machines I provide means for circulating the asphalt through a tank in which it may be superheated so as to insure that it will remain at the proper temperature not only in the main tank but in the pressure saturating chamber. In both forms of machine it will be observed that the heating elements in the main tank for heating the asphalt comprise portions which are located in the pressure saturating chamber.

It will also be noted that the throats through which the felt passes into and out of the pressure chamber are submerged in the hot asphalt being below the levels of the saturant in both the tank and the chamber and subjected to contact with the hot asphalt on both sides. This causes these throats to be of the same temperature as the asphalt so that they do not become fouled by solidfied saturant. Furthermore all the leakage therethrough in either direction is of asphalt which is much slower in flowing than air so that even if considerable leakage were present, the different pressures within and without the chamber would be little affected. Furthermore the escape of air under pressure along the sheet material would be likely to cause the surface coating of asphalt to be blown off beyond the throat while leakage of saturant can not have any such effect. The fact that pressure is produced by elastic pressure further insures that any unavoidable leakage shall not materially affect the pressure. The throats may in practice be considerably longer than the width of the sheet under these conditions without material detriment to the action of the apparatus, and as it is impracticable to attempt to confine the sheet closely to a definite lateral position in its comparatively soft condition while it is being treated by the saturant, this action of the submerged throats is of considerable importance.

What I claim is:—

1. An apparatus for saturating fibrous sheet material, comprising a saturating chamber adapted to contain a saturating compound, means for periodically feeding successive lengths of said sheet material through said chamber into contact with said saturating compound, and means for increasing the pressure in said chamber to act on each successive length.

2. An apparatus for saturating fibrous sheet material, comprising a saturating chamber adapted to contain a saturating compound, means for feeding successive lengths of said sheet material through said chamber into contact with said saturating compound, and means for automatically and periodically varying the pressure in said chamber.

3. An apparatus for saturating fibrous sheet material, comprising a saturating chamber adapted to contain a saturating compound, means for feeding successive lengths of said sheet material into said chamber and bringing them to a state of rest in contact with said saturating compound, means for closing said chamber, and means for periodically varying the pressure in said chamber.

4. An apparatus for saturating fibrous sheet material, comprising a saturating

chamber adapted to contain a saturating compound and having provisions for permitting the passage of a sheet of material through the saturating compound therein, and mechanism for automatically varying the internal pressure in said chamber.

5. Apparatus for saturating fibrous sheet material, comprising a saturating chamber adapted to contain a saturating compound, means for intermittently feeding successive lengths of said sheet material through said compound, and automatic mechanism for automatically varying the internal pressure in said chamber.

6. Apparatus for saturating fibrous sheet material, comprising a saturating chamber adapted to contain a saturating compound, mechanism for varying the internal pressure in said chamber, means for feeding the said sheet through said chamber, and automatic take-up mechanism for automatically taking up and letting out portions of the sheet on both sides of said chamber.

7. Apparatus for saturating fibrous sheet material, comprising a saturating chamber adapted to contain a saturating compound and adapted to permit the passage of the sheet therethrough, an air compresser, and connections between said chamber and said compresser whereby the internal pressure in said chamber is periodically increased.

8. Apparatus for saturating fibrous sheet material, comprising a saturating chamber adapted to contain a saturating compound and adapted to permit the passage of the sheet therethrough, an air compressor, connections between said chamber and said compresser whereby the internal pressure in said chamber is increased, and an automatically operated valve located in said connections.

9. Apparatus for saturating sheet material, comprising a closed saturating chamber having one or more throats for the entrance and exit of the sheet therethrough, automatic valve mechanism for closing said throat or throats, and automatic means coordinated with said valve mechanism to vary the internal pressure in said chamber when said throat or throats are closed.

10. Apparatus for saturating sheet material, comprising a closed saturating chamber having one or more throats for the entrance and exit of the sheet therethrough, automatic valve mechanism for closing said throats, and automatic means coordinated with said valve mechanism to increase the internal pressure in said chamber when the throat or throats are closed and decreasing the internal pressure when they are open.

11. Apparatus for saturating sheet material, comprising a closed saturating chamber, having means for the entrance and exit of the sheet of material therethrough, mechanism for automatically closing said means, means for automatically feeding said sheet through said chamber, and take-up mechanism to take up and let out the sheet whereby successive lengths of said sheet periodically come to a state of rest in said chamber.

12. Apparatus for saturating sheet material, comprising a tank for containing the saturating compound, a chamber in said tank adapted to contain said compound, means for guiding said sheet through the compound contained in said tank outside of said chamber and the compound contained in said chamber, and means for increasing the internal pressure in said chamber.

13. An apparatus for saturating sheet material, comprising a tank for containing saturating compound, a chamber in said tank also adapted to contain said compound, means for guiding the sheet through the compound contained in said tank outside of said chamber and the compound contained in said chamber means for subjecting the compound in said chamber to pressure different from the compound in said tank, and means for elevating said guiding means for facilitating the threading of the sheet through said guiding means.

14. Apparatus for saturating sheet material, comprising a tank for containing the saturating compound, a chamber in said tank adapted to contain said compound and having a removable upper section, guiding means for the sheet connected to said section, and mechanism for elevating said section and said guiding means above the level of the compound in said tank.

15. An apparatus for saturating sheet material, comprising a tank for containing saturating compound, a chamber in said tank also adapted to contain said compound, means for guiding the sheet through the compound contained in said tank outside of said chamber and the compound contained in said chamber, and means for subjecting the compound in said chamber to pressure different from the compound in said tank.

16. An apparatus for saturating fibrous material, comprising a chamber adapted to contain molten asphalt, means on both sides of said chamber for feeding a sheet continuously, and take-up mechanism located between said feeding means and said chamber for operating on said sheet whereby an intermittent or periodic feeding of said sheet through said chamber is effected.

17. An apparatus for saturating fibrous material, comprising a chamber adapted to contain molten asphalt, means on both sides of said chamber for feeding a sheet continuously, take-up mechanism located between said feeding means and said chamber for operating on said sheet whereby an intermittent or periodic feeding of said sheet through said chamber is effected, and means

for varying the internal pressure in said chamber.

18. An apparatus for saturating sheet material, comprising a tank adapted to contain a molten bituminous compound, a pressure chamber in said tank, means for guiding a sheet of felt through said tank and chamber, a superheating tank adapted to contain said compound, and means for effecting a cyclic circulation of said compound through said tank and superheating tank.

19. An apparatus for saturating sheet material, comprising a tank adapted to contain a molten bituminous compound, a pressure chamber in said tank through which a sheet of fibrous material may be passed after passing through the compound in said tank, means for effecting a continuous feed of the sheet entering and leaving the tank, and take-up mechanism for effecting an intermittent or periodic feed of the sheet through said chamber.

20. An apparatus for saturating sheet material, comprising means for coating said sheet material progressively with a bituminous compound, and means for subjecting successive portions of said coated sheet to increased and diminished pressure greater and less than atmospheric in alternation.

21. An apparatus for saturating sheet material, comprising a saturating chamber having provisions for the passage of successive portions of the sheet therethrough, a pressure tank, a vacuum tank, and means for connecting said last mentioned tanks alternately with said saturating chamber.

22. An apparatus for saturating sheet material, comprising a saturating chamber having provisions for the passage of successive portions of the sheet therethrough, an air pressure tank, a vacuum tank, a pipe in said chamber having its open end above the level of the saturating compound therein, and means for automatically connecting said tanks alternately with said chamber whereby the sheet in passing through said chamber is subjected to pressure and vacuum alternately.

23. An apparatus for saturating sheet material, comprising a saturating chamber having provisions for the passage of successive portions of the sheet therethrough, an air pressure tank, a vacuum tank, a pipe in said chamber having its open end above the level of the saturating compound therein, means for automatically connecting said tanks alternately with said chamber whereby the sheet in passing through said chamber is subjected to pressure and vacuum alternately, and means for intermittently feeding successive lengths of the sheet into said chamber.

24. An apparatus for saturating sheet material, comprising continuously operated sheet-feeding rolls, a pressure-saturating chamber, and means operating in timed relation to said rolls for automatically increasing and diminishing the pressure in said chamber.

25. An apparatus for saturating sheet material, comprising continuously operated sheet-feeding rolls, a pressure-saturating chamber, means operating in timed relation to said rolls for automatically increasing and diminishing the pressure in said chamber, and mechanism also operating in timed relation to said rolls for intermittently feeding successive lengths of said sheet into said chamber and permitting the same to come to a state of rest therein.

26. An apparatus for saturating sheet material, comprising a pressure saturating chamber adapted to contain a saturating compound and having a throat for the passage of the sheet material closable against said material, means for feeding the sheet through said throat when the throat is open, and means for effecting a high pressure in said chamber when the throat is closed.

27. An apparatus for saturating sheet material, comprising a pressure saturating chamber adapted to contain a saturating compound and having a throat for the passage of the sheet material closable against said material, means for periodically opening and closing said throat, means for effecting a high pressure in said chamber when said throat is closed, and means for feeding the sheet through said throat when said throat is open.

28. A method of saturating fibrous sheet material of indeterminate length, which comprises passing successive lengths of a sheet into a bath of saturating compound and bringing the same periodically to a state of rest therein, varying the pressure on said bath to saturate said lengths in succession, and continuously moving the remainder of the sheet.

29. A method of saturating fibrous sheet material of indeterminate length, comprising passing such sheet into complete surface contact with molten asphalt, then subjecting such sheet to a vacuum, and then bringing such sheet into complete surface contact with molten asphalt.

30. A method of saturating fibrous sheet material of indeterminate length, comprising passing such sheet into complete surface contact with molten asphalt, then subjecting such sheet to a vacuum, and then bringing such sheet into complete surface contact with molten asphalt under pressure.

31. Apparatus for saturating fibrous sheet material, which comprises means for feeding an indeterminate length of said sheet material continuously in one direction, and means for intermittently feeding successive

lengths thereof through a saturating compound under pressure in all directions above atmospheric and that due to the hydrostatic head of the saturant.

32. An apparatus of the class described, comprising, in combination, means for subjecting sheet material of indeterminate length to surface contact with bituminous compound, and means for subjecting successive portions of said sheet so subjected alternately to pressure lower and higher than atmospheric while said portions are in contact with the compound, all adapted for continuous operation.

33. An apparatus for saturating fibrous material, comprising a saturating tank, a chamber in communication with said tank, said tank and chamber being adapted to contain saturant, means for subjecting the saturant in said chamber to a different pressure than the saturant in said tank, a restricted throat in said chamber normally below the level of the saturant and through which said sheet material passes, guides for directing said sheet material through the saturant in said chamber, and means actuable to so dispose the several parts of the apparatus that said material may be threaded therethrough entirely above the level of the saturant.

34. The method of saturating fibrous sheet material of indeterminate length, which comprises periodically feeding successive lengths of the sheet into contact with the liquid saturating compound, and between the feeding periods subjecting the compound and the length of the sheet material in contact therewith to pressure greater than atmospheric and the hydrostatic pressure of said compound to force said compound into said sheet material.

35. Steps in the continuous manufacture of saturated roofing felt, which comprise supplying a sheet of raw felt of indeterminate length in a substantially continuous manner, clamping and periodically enclosing successive portions of said sheet in a body of saturating compound, and subjecting the body of compound to pressure different from atmospheric while the sheet portions are held clamped.

36. Steps in the continuous manufacture of saturated roofing felt, which comprise supplying a sheet of raw felt of indeterminate length in a substantially continuous manner, clamping and periodically enclosing successive portions of said sheet in a body of saturating compound, and subjecting the body of compound to pressure greater than atmospheric while the sheet portions are held clamped.

37. Steps in the continuous manufacture of saturated roofing felt, which comprise supplying a sheet of raw felt of indeterminate length in a substantially continuous manner, clamping and periodically enclosing successive portions of said sheet in a body of saturating compound and subjecting the body of compound to pressure alternately less and greater than atmospheric while the sheet portions are held clamped.

38. A method of saturating fibrous sheet material of indeterminate lengths, which comprises continuously feeding said sheet into a liquid bituminous compound, subjecting both faces of said sheet to surface contact with bituminous compound, exposing successive portions of said sheet so subjected alternately to a vacuum and to pressure in excess of atmospheric, and feeding said sheet continuously out of said bituminous compound.

39. A method of saturating fibrous sheet material of indeterminate lengths, which comprises feeding said sheet continuously into a liquid bituminous compound, thereby subjecting said sheet to surface contact with said compound at atmospheric plus the hydrostatic pressure of the compound, intermittently subjecting successive portions of said sheet in the presence of a bituminous saturating compound to heat and fluid pressure greater than the atmospheric plus hydrostatic pressure, and continuously feeding said sheet out from the compound.

40. A method of saturating fibrous sheet material, which comprises passing successive predetermined lengths of said material into a liquid saturating compound, and subjecting the compound acting on the successive lengths to different pressures of which one is greater and another is less than atmospheric.

41. Apparatus for saturating fibrous sheet material, which comprises means for subjecting said sheet to surface contact with saturating compound at atmospheric pressure, and means for passing said sheet through saturating compound under a pressure greater than atmospheric and the hydrostatic pressure of the saturating material in a continuous operation.

42. An apparatus for saturating sheet material, comprising a saturating chamber adapted to contain a liquid saturating compound, means for periodically decreasing and increasng pressure on the compound in said chamber, and means for feeding sheet material of indeterminate length through the compound in said chamber whereby said sheet is saturated with said compound.

43. An apparatus for saturating sheet material, comprising a tank and a chamber both adapted to contain a liquid saturatng compound, means for increasing the pressure on the saturant in said chamber above atmospheric, and means for feeding successive lengths of a continuous strip of sheet material through the saturant in said tank,

then through the saturant in said chamber, and then through the saturant in said tank the saturant in said tank being subjected to atmospheric pressure.

44. An apparatus for saturating sheet material, comprising means for subjecting the material to surface contact with saturating compound, a chamber for containing saturant, means for passing the material after its initial contact with the saturant into the chamber, and means for varying the pressure on the saturant in said chamber.

45. An apparatus for saturating fibrous material, comprising a tank, a chamber, said tank and chamber being adapted to contain saturant, and means for subjecting saturant in said chamber to a different pressure from the saturant in said tank, said tank and chamber being in communication below the level of saturant therein, and means for leading the fibrous material through the saturant in said tank into said chamber and out from said chamber into said tank, all below the level of saturant therein.

46. The method of saturating fibrous sheet material with a saturant solid at atmospheric temperatures, which comprises passing said sheet material into hot melted saturant under atmospheric pressure to coat the surface thereof and heat the material, and then into hot melted saturant under greater than, less than and then greater than atmospheric pressure to force the saturant into the voids of the material and to permit the air and moisture in these voids to escape.

47. An apparatus for saturating fibrous material which comprises means for continuously feeding spaced portions of the material, means for intermittently feeding an intermediate portion of the material, and means for saturating said intermediate portion while it is stationary.

48. An apparatus for saturating fibrous material which comprises means for continuously feeding spaced portions of the material, means for intermittently feeding an intermediate portion of the material and taking up, letting out and supporting the material between said intermediate and spaced portions, and means for saturating said intermediate portion while it is stationary.

49. Apparatus for treating fibrous material in web form in a continuous manner, which comprises means for continuously feeding and partially saturating the web, and means for intermittently feeding an intermediate portion of said web, combined with means for further saturating the intermediate portion while it is stationary.

In testimony whereof I have affixed my signature.

ROBERT T. JOHNSTON.