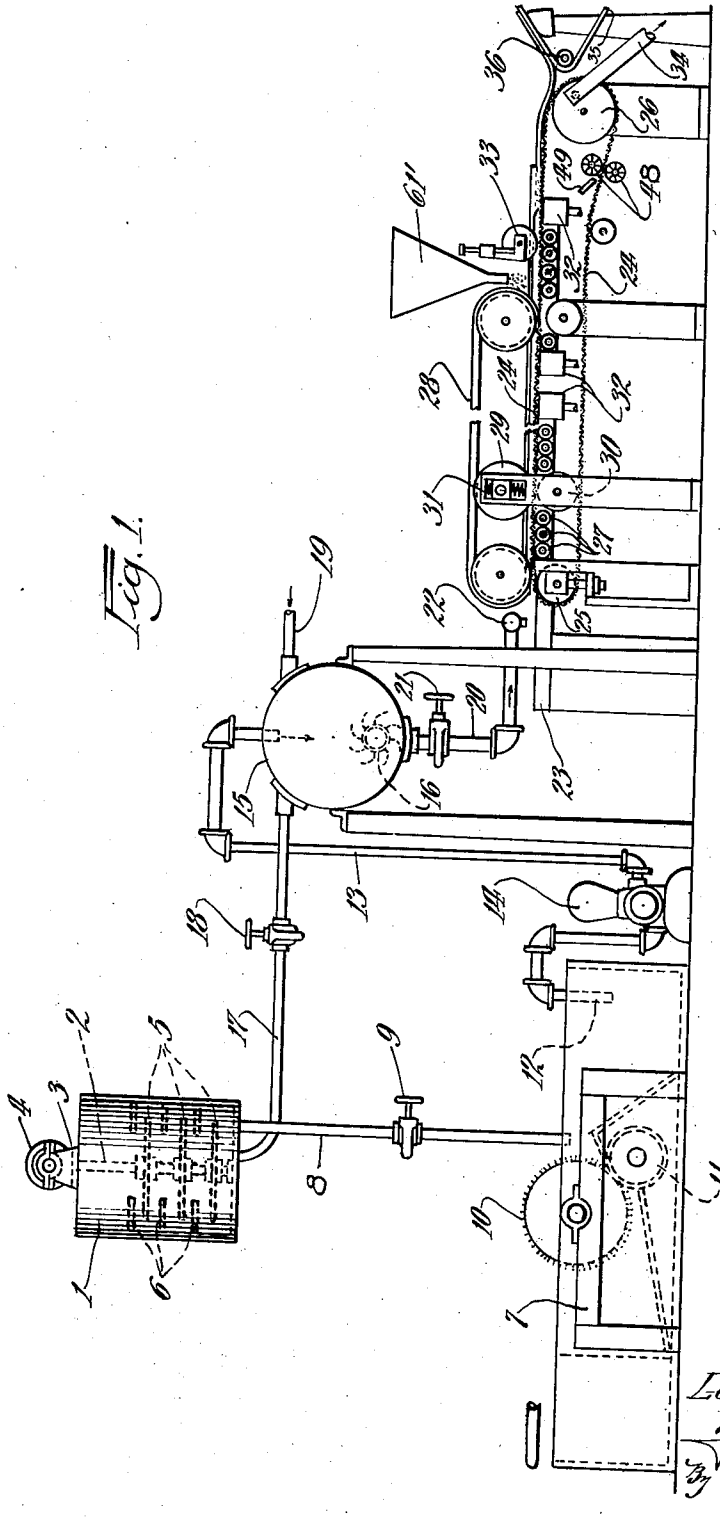
July 30, 1929. L. KIRSCHBRAUN 1,722,434

PROCESS OF MAKING FELTED FIBROUS COMPOSITIONS

Original Filed Nov. 19, 1924 3 Sheets-Sheet 1

Fig. 1.



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PROCESS OF MAKING FELTED FIBROUS COMPOSITIONS

Original Filed Nov. 19, 1924 3 Sheets-Sheet 2

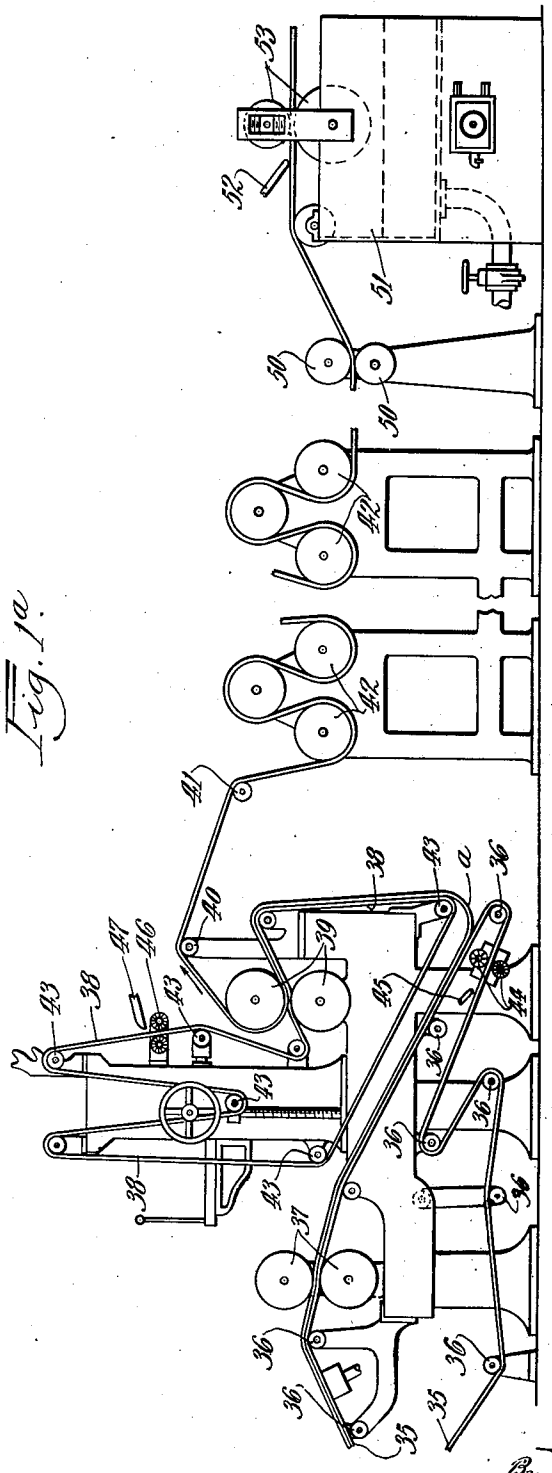


Fig. 1a.

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PROCESS OF MAKING FELTED FIBROUS COMPOSITIONS

Original Filed Nov. 19, 1924 3 Sheets-Sheet 3

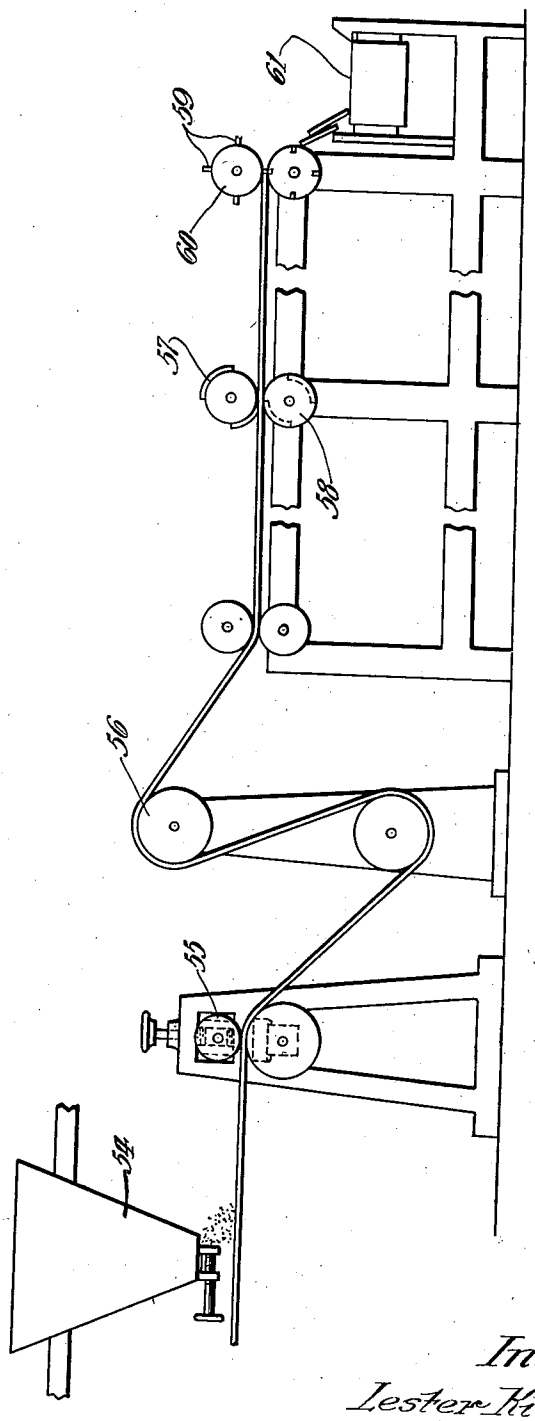


Fig. 16.

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UNITED STATES PATENT OFFICE.

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PROCESS OF MAKING FELTED FIBROUS COMPOSITIONS.

Original application filed November 19, 1924, Serial No. 750,927. Divided and this application filed April 15, 1927. Serial No. 184,074.

This application is a division of my application Serial No. 750,927 filed November 19th, 1924.

The salient object of this invention is the production of a waterproof paper in which the waterproofing agent is incorporated into the paper simultaneously with the felting operation.

In the drawings:

Figs. 1, 1A and 1B taken together indicates a more or less diagrammatic showing of an apparatus suitable for carrying out the present invention.

Referring to the drawings, 1 designates an emulsifying tank adapted to receive asphalt or other binder, and an emulsifying agent such as clay and water. This tank may be of any suitable construction and is provided with a rotating shaft 2 driven through gears 3 and 4, leading to any source of power. The shaft 2 carries a series of arms 5 cooperating with stationary arms 6 secured to the side of the emulsifier. The object of this emulsifier is to form an emulsification of the binder and emulsifying agent such as clay, etc. In making this emulsified composition, the clay is put into the emulsifier and water is gradually added until a paste or doughy mixture is obtained. Asphalt or other pitchy binder is then slowly stirred into this paste and water is gradually added from time to time to obtain a working consistency. The water is preferably warm or hot. This mixture is thoroughly beaten up until the binder is uniformly dispersed through the emulsifying agent, the object being to reduce the binder to a very fine state of division and thoroughly mix it with the clay. It is to be understood that other emulsifying agents than clay, may be used and in certain cases other binder might be used such as hereinafter designated.

This mixture contained in the emulsifier can be delivered to a beater 7 through a pipe controlled by valve 9. The beater 7 is of a construction adapted for converting stock into pulp and is provided with a suitable beating roll or arms 10 and 11. The pulp which I use may be made from any suitable fibrous material such as paper waste, tan bark, wood pulp, cotton waste, grassy fibres, and hemp. After the fibre is beaten to a pulp, the pulp is delivered by means of pipes 12 and 13 and pump 14 to a mixing tank 15. This tank 15 is provided with a mechanical agitator 16 driven from any suitable source of power. The emulsified mixture heretofore referred to instead of being delivered to the beater 7 may be delivered direct to the mixing tank through pipe 17 controlled by valve 18. If the emulsified composition is delivered directly to the beater it is closely and thoroughly beaten into amalgamation with the pulp, and if it is delivered directly to the mixing tank it is there mixed with the pulp in such a way as to thoroughly amalgamate with the latter. It will be desirable in many cases to add a filler to the mixture which may be of such relatively cheap materials as saw dust, sand, ground cork or any suitable comminuted material. It may be desirable to add more clay to the mixing tank also. The mixture in the tank 15 is thinned to the desired consistency by adding as much water as desired through the pipe 19. The consistency of the mixture in the mixing tank will depend upon the character of the product to be formed and also upon the character of the material in the mixing tank. In the formation of roofing compositions, the mixture I have found, in certain cases, should be sufficiently liquid to permit the fibres to more or less flow in the water so that they will have opportunities to interlock and interlace with each other when the water is separated out. It is also very important that the materials be sufficiently mixed to insure a thorough amalgamation of the fibre with the emulsified binder and with such filler, if a filler be used. The materials in question should be so mixed that when in an aqueous solution they will be free of any tendency to be sticky or adhere to the machine. It may be here noted that when the emulsified composition is formed, the particles of the binder should be so thoroughly and finely dispersed through the aqueous paste that the particles of the binder will tend to be thoroughly separated from each other and surrounded by the clay and water. The operator may ascertain that the emulsification has been sufficient by manual manipulation. If properly emulsified it will have a smooth, soapy feeling and be free from any tendency to exhibit adhesiveness.

After the material is thoroughly mixed it is delivered to the sheet forming mechanism through pipe 20 controlled by valve 21. The delivery end of the pipe 20 is provided with a nozzle 22 which is preferably the width of the sheet desired. The nozzle 22 delivers the mixture to a box 23 which overflows in an

endless travelling screen 24. This screen 24, which may be of a construction similar to those used in the papermaking industry, may be a foraminated brass belt which is trained around rollers 25 and 26. Intermediate idler rollers may be provided as desired. The upper lap of the belt travels across rollers 27 forming in effect a table or support for the belt. At either side the screen is provided with confining belts 28; it being understood that these belts serve to prevent the material from flowing over the sides of the travelling screen.

Preferably spreader or distributing rolls 29 and 30 are provided and the frame spring gripped as shown at 31. As shown in Fig. 1, the apparatus is broken away to reduce the size of the drawings, the endless screen is of sufficient length to allow the desired amounts of water to drain through the screen. To facilitate the removal of the water from the sheet, I provide a plurality of suction boxes 32 and intermediate pressure rolls 33, a further suction pipe 34 may be provided to remove further water if desired.

In forming, the sheet passes over the foraminated belt or screen into a canvas or other fabric belt 35, which is trained around a series of rolls 36 and driven from any suitable source of power. Pressure rolls 37 may also be provided. The now formed sheet *a* is threaded up over the belt 38 to feed rolls 39 and thence up over rolls 40 and 41 to a series of drying rolls 42. The belt 38 serves to take up the surplus moisture and it is thereafter dried by passing it around rolls 43.

The belt 35 may be cleaned by means of rotating brushes 34 and suitable water jets 45. The belt 38 can also be cleaned by brushes 46 and jet nozzle 47, and the screen 24 by brushes 48 and jet nozzle 49. It will be understood, however, that one of the important features of the present invention is that the mixture which is to be sheeted is of such character that it can be readily washed off of the various belts and will not stick thereto.

After the now formed sheet leaves the rolls 42 it passes through rolls 50 to the coating mechanism 51, which is provided with delivery pipe 52 for the coating material, and pressure rollers 53 which may be of any suitable construction. If granular faced roofing is being formed, the coated sheet can be fed beneath hopper 54 containing suitable granular material so as to cover the face of the roofing. The sheet then coated and covered with granular material is passed between presser rolls 55 and thence over cooling rolls 56 to slitting knives 57 carried by roll 58. The sheet which is now severed longitudinally may be cut transversely to form shingles or shingle strips by passing through transverse knives 59 carried by rollers 60. It is to be understood of course, that these knives and rolls are so geared as to operate synchronously. The shingles or shingle strips are then carried away by travelling conveyor belt 61.

The apparatus here shown is adapted for making shingles or shingle strips of prepared roofing such as asphalt shingles and the like, but it is to be understood that the sheet after having been formed may be treated in any desired manner, such for example, as having a design printed thereon, etc.

It may be desirable in certain instances to put a granular facing over the sheet and dispense with the coating. This may be done by impressing granular material on the sheet through the hopper 61′ while the sheet is still in sufficiently plastic condition to permit the granular material to become partially embedded in and adhere to the sheet. In other cases it may be desirable to give a color or luster to the roofing and this can be accomplished by covering the granular facing of the roofing after it is applied with a film of silica of soda and a pigment or dye, the pigment or dye giving the desired color.

An essential feature of this process resides in the conversion of asphalt or other bituminous or hydrocarbon material, which is normally of an adhesive nature into a finely divided non-adhesive form. This transformation is accomplished by a process of dispersion of the asphalt into water by means of an emulsifying agent. The asphalt used is solid or semi-solid at ordinary temperature and is of a character similar to that which is employed for the purpose of waterproofing felts, fabrics and the like as in the manufacture of prepared roofings. The asphalt may either be a native asphalt, pure or containing mineral matter softened, if desired, by means of fluxing oils, or may be the product of distillation or oxidation of asphaltic petroleums in a well known manner. It is the nature of such asphalts that, when they are placed in contact at moderate temperatures to coalesce or adhere so as to form a coherent and homogeneous mass and this is an essential characteristic of such asphalts as are used in the manufacture of the stock for particular purposes to be referred to hereinafter. In place of asphalts such as described, I may also employ tars and pitches of vegetable, animal or mineral origin, resins or resinous materials softened, if desired, with tempering oils so as to bring them to the proper consistency for the purpose intended, and such substances are regarded as comprehended by the term "asphalt" as employed herein. Heretofore while it has been proposed to form various waterproof compounds containing fibres to be made or produced in block or sheet form, such materials could not readily be used in connection with the usual web forming machines such as are employed for example in the manufacture of felt or paper for the reason that the stock including the contained as-

phalt was of such an adhesive nature as to cause the gumming of the machinery and blankets. Of course, if the pitch be of such solidity at ordinary temperatures that it is capable of being ground or comminuted like gilsonite it may be mixed with fibre just as particles of charcoal are mixed, but in that event, such pitchy particles are not adhesive at ordinary temperatures at which the stock is maintained when the web is being formed into paper, and the subsequent evaporization of the water or subjection of the web to pressure would not cause the coalescence of the pitchy particles in the web, and the water-proofing of the fibres.

While the asphalt herein referred to is designated as being solid or semi-solid at atmospheric temperatures, nevertheless, it is well known that materials of this character are scientifically or more correctly known to be liquids of exceedingly great viscosity, so that while capable of being handled en masse, nevertheless, they flow slowly at ordinary temperatures and require a containing vessel in order to confine them. Materials of this character are readily liquifiable by heat, exhibiting a gradual decrease in viscosity with the elevation of temperature. Such solid or semi-solid asphalts as require the application of heat as distinguished from liquid asphalts are most readily adapted to produce this non-adhesive emulsion. The liquid asphalts, i. e. those capable of being emulsified without the application of heat, while convertible to a relatively non-adhesive form, are nevertheless too easily affected by the pressures employed during the felting operation, so that they become sticky when used on the paper machine. The selection of asphalt of proper character and consistency is therefore an important item in producing the non-adhesive emulsion. For the purpose of this process as stated before, it is necessary to convert this adhesive asphalt into a finely divided non-adhesive form in which it may be mixed with fibre stock and water and produce a non-adhesive and non-coherent mixture that is capable of being flowed into web form in much the same way that ordinary fibre or paper stock is caused to form a web.

In paper stock it is necessary, as is well known, to have a sufficient quantity of water in order that the web forming materials may spread themselves in a web, and consequently in any emulsion which is used for this purpose it is necessary that the water constitute the external or continuous phase so that additional water may be supplied to form a freely flowing mass, and yet be capable of extraction or expression when the web is produced. So far as I am aware, with the information previously supplied it has been considered impossible heretofore to produce an aqueous emulsion of asphalt which is non-adhesive under the conditions prevailing in heating stock and under the pressures employed in forming a web on the paper machine, and it has also been impossible to prepare an emulsion of this character in which has been carried the large amount of asphalt relative to the paper stock which is necessary to produce completely waterproofed sheet of felted fibres. I am aware that emulsions of soaps and resinous materials have been used heretofore for the purpose of sizing paper stock to make it water resistant, but such emulsions have been used under conditions in which the soluble soap employed as an emulsifying agent is reacted upon chemically prior to the formation of the web so as to break the emulsion and precipitate insoluble and more or less non-adhesive soaps or resinates upon the fibres. The present process contemplates the use of no chemicals or reagents which disturb the emulsion or change its non-adhesive character at any stage of the operation prior to the complete removal of water;—the transformation from non-adhesive to adhesive character of the asphalt being accomplished only by the removal of water, through the application of pressures or heat, or both.

In order to produce the emulsion above referred to, I use clay containing a large proportion of colloidal material as an emulsifying agent, but obviously other finely divided powders or collodial materials which produce an emulsion of a non-adhesive character may be used in lieu thereof.

The emulsion may be produced in batches or by a continuous process. If prepared as a batch, I first make a thick aqueous suspension of the clay and heat it to a temperature approximating the melting point of the asphalt which is to be emulsified. The asphalt is also heated until it is quite fluid, the temperature varying with the viscosity of the asphalt and its melting point. Preferably a temperature of 300 to 400 degrees F., is employed for the harder varieties of asphalt while for the softer varieties a lower temperature affords the desired degree of fluidity. The aqueous suspension heretofore referred to is produced in a vessel having means for rapidly agitating the contents thereof. Its consistency is such that it is too fluid to hold its form but sufficiently liquid to flow slowly through a fair sized orifice. It is important that the consistency of this paste be regulated within more or less definite limits as the degree of dispersion obtained during the emulsifying operation depends largely upon the viscosity of the internal friction resulting in the agitation of the asphalt throughout the viscous clay suspension.

The molten asphalt is gradually added to the viscous suspension while the mass in the vessel is being subjected to rapid agitation. This is important in order to avoid inversion of phase and production of an adhesive emul-

sion. As the asphalt is introduced and continuously emulsified, the mass thickens and it becomes necessary to add water in order to maintain the desired viscosity of the contents of the vessel. The addition of asphalt is continued, alternating with the additions of water and in such quantities as to maintain the desired consistency. If the vessel is sufficiently large, water and asphalt may be added simultaneously in the desired proportions. It is advantageous to maintain the temperature of the asphalt above the boiling point of water as the expansive force of the steam generated upon contact of the asphalt with the aqueous suspension produces, by more or less foaming, an extension of surface of the pitchy material during its incorporation. The mechanism of this dispersing operation is somewhat as follows: as the asphalt strikes the thick aqueous suspension, it becomes immediately subjected to the agitating arms of the mixer. These arms produce rapid extension and subdivision of the stream of pitch into very fine threads throughout the mass of clay suspension. The viscosity of the thick suspension assists in the formation of these threads and their fine degree of attenuation. At the same time the formation of bubbles induced by the steam generated, assists in the production of thin films and threads of the asphaltic material. As these threads are being rapidly formed and rapidly attenuated, a point is reached depending upon the temperature of the mass, its viscosity and rapidity of agitation, at which the threads have become so fine and their surface so great that they become rapidly broken and subdivided into filaments which in turn become subjected to further subdivision until their length is such that their surface tension causes the minute threads thus formed to assume a globular spherical form. This dispersion is produced not only under the conditions and by the mechanical agency above referred to, but also through the presence of the colloid which in effect increases the surface tension of the more or less molten pitch undergoing dispersion or decreases that of the dispersive medium.

As a result of this operation the asphaltic material referred to becomes dispersed throughout the aqueous suspension into very minute particles. Under the microscope these particles exhibit a spherical or elliptical form depending on the temperature and conditions of dispersion. The more perfect the dispersion, the more nearly spherical and the finer are the resulting particles. Their size varies, ranging from particles which are probably of colloidal dimensions to those which can be seen as individual particles with the naked eye. The average size of the particles is about .01 millimeter. Some of the smaller particles exhibit distinctive Brownian movement. It should be noted that although the pitch is in liquid condition while being dispersed, the form of the particles or relation of phases does not change upon cooling and upon more or less hardening or solidification of the pitch in its subsequent reduction to normal temperatures. The emulsion thus formed has the peculiar characteristics of not being affected by electrolytes but precipitates a positively charged colloid as ferric oxide sol. The emulsion itself is weakly electro-negative. It will be observed that in the system so produced the asphalt constitutes the dispersed or internal phase while the external or continuous phase comprises the water with the suspended clay colloid. This constitution of phases with the water as the external phase permits the dilution or admixture of water with the emulsion in all proportions so that when applied to the fibre stock the necessary quantities of water may be added to accomplish the desired web forming operation.

It is important to note that a desirable feature in the preparation of this emulsion resides in the degree of dispersion of the asphalt particles throughout the continuous phase. The fineness of dispersion is to a considerable extent regulated by the viscosity of the mass during agitation and by its temperature. For example, if the clay suspension be too thin, and the necessary internal viscosity be lacking, the threads formed during the initial stages of dispersion are relatively coarse, and the material thus comminuted may maintain various coarse stages of subdivision ranging from relatively coarse threads down to the finer particles. Likewise if the temperature of either the asphalt or the suspension is too low, coarse particles are similarly formed. On the other hand, should the temperature of the pitch or the partially formed material be too great, there is danger of partial or local coalescence of the previously formed material, due probably to the complete removal of water by heat from around some of the asphalt particles at the point of confluence with the incoming hot liquid asphalt. Furthermore, care should be taken to have sufficient water present at all times as otherwise the asphalt will agglomerate producing complete inversion of the phase, the water and clay constituting the internal phase with the asphalt as the continuous medium. The degree of dispersion attained, plays, I believe, an effective part in causing the material to retain its non-adhesive character in the highest and more persistent degree. The process of dispersion, I believe, results in the formation of heavily absorbed films of water and clay colloid about the individual particles of asphalt. I believe that the finer the degree of dispersion attained and the greater the surface energy thus resulting, the more tenaciously is this protective film retained about the particles, so that in subse-

quent operations of forming paper, this protective coating is not readily broken or disturbed and is only disrupted after the water has been to the largest extent expressed by the drying of the sheet. The larger the particles, the more easily is this film disturbed in which case such larger particles are more readily affected by the pressures employed upon the paper machine and the greater will be the tendency for the asphalt to become adhesive through the easy removal of the protective coating. I have found when using asphalt of about 140 melting point, a desirable temperature at which to maintain the clay suspension is about 150 degrees F., and a satisfactory temperature at which to carry the asphalt is about 325 to 350 degrees F., the temperature of the batch being maintained during the addition of the hot asphalt by the introduction of further quantities of water at a proper heat to compensate for the temperature of the incoming asphalt.

When it is desired to hold the temperature of the batch or bulk supply above 212 degrees F., in order to more advantageously emulsify very viscous materials, such as high melting point oxidized asphalts, the emulsifying apparatus is sealed and the entire operation is carried on at pressures above atmospheric. It is thereby possible to maintain a temperature above the boiling point of water without permitting evaporation or boiling away of any substantial portions of water from the apparatus.

The non-adhesive character of the emulsion and its desirable degree of dispersion may be roughly followed by manual manipulation. A quantity of material when worked between the fingers should feel smooth, plastic, slippery and free from grit particles and should exhibit no tendency for the particles of asphalt to agglomerate among themselves when pressed or rubbed between the fingers. In fact, the emulsion thus produced should feel substantially like the thick clay suspension originally employed in its production. It should be readily washed from the hands with water and should be capable of dilution in all proportions with further quantities of water. If it should be desired to retain the asphalt particles in suspension to the best possible extent, a protective non-adhesive colloid may be added after the emulsification has been completed.

In order that this emulsion should be capable to the greatest possible extent of being carried in large quantities by the fibrous stock, it is desirable that the proportion of asphalt to clay be large. The amount of asphalt which can thus be emulsified depends considerably upon the clay, apparently varying with the amount of colloidal matter in such clay, thus clays carrying the largest amount of colloidal matter being capable of carrying the larger amounts of asphalt. By using the proper quality of clay I have been able to make an emulsion containing as much as ten parts of asphalt, by weight, to one part of clay. Ordinarily, however, portions of four or five parts of asphalt to one part of clay will be found most satisfactory although smaller proportions may be employed where the amount of asphalt to be contained in the final paper product is small and does not contemplate its complete saturation. An analysis of a typical emulsion made by the operation above indicated, would show approximately 50% by weight of asphalt, 10% by weight of clay and 40% by weight of water.

I have heretofore described a batch process for producing this emulsion but I have found where large quantities are required, that it is most desirable to effect its manufacture as a continuous operation. For this purpose, I have provided a mixer or an emulsifying apparatus provided with helical blades mounted upon a rapidly revolving shaft. As an initial stage in producing the emulsion this apparatus is charged with the aqueous suspension or with finished product as before described for batch operation. The agitation blades are so disposed as to cause a rapid incorporation of liquids introduced at the top of the vessel with the bulk contents of the container.

After the initial charge of suspension or emulsion has been prepared of the desired viscosity, asphalt in a heated liquid condition is fed into the mass preferably as it circulates downward. Simultaneously there is fed a thin aqueous suspension of the emulsifying agent in regulated and predetermined proportions corresponding to the proportions desired in the final emulsified composition. For example, if an emulsion of the composition above described is desired, the aqueous suspension is made up in proportions of one part by weight of clay and four parts by weight of water. This suspension is fed to the emulsifier as previously described continuously and in predetermined quantities and simultaneously with the introduction of asphalt in like regulated quantities. By regulation of the volume of the incoming streams of asphalt and suspended emulsifying agent and by continuous withdrawal of the finished product from the system, an emulsified composition of the character above described will be produced.

In the producing of emulsion thus continuously, it is important to maintain substantially similar conditions of viscosity in the circulating mass of finished and surplus emulsion always contained in the system. The retention of this quantity of surplus emulsion in the system acts as a balance wheel against minor variations of viscosity and temperature due to momentary introduction of excess of either asphalt or clay suspension. It will be evident that on account of such

minor variations and the necessity for maintaining nearly constant conditions of proportions, temperature and viscosity, it is advantageous to maintain as large a bulk supply of finished emulsion in the system as is compatible with the rate of introduction of incoming ingredients and the withdrawal of the finished product from the mixer.

The product of this continuous operation is in all respects the same as that produced by batch operation previously described. As taken from the mixer, it is viscid consistency but not so stiff as to prevent its ready egress from the orifice provided for its withdrawal. As fast as produced this emulsion is preferably thinned with water so as to facilitate its transfer by pumps to the storage tanks and receptacles wherein it is held in suspension for admixture with the paper stock. These tanks or receptacles in which the emulsion is stored are preferably provided with mechanical agitators which serve the purpose of maintaining a uniform suspension of the asphalt throughout the aqueous medium.

In the manufacture of paper by means of this process the stock is prepared in the usual manner by beating, jordaning and screening. Various stocks may be used such as sulphite, sulphate, rag fibres, mixed papers, mechanical wood, leather, to which if desired, may be added sawdust. In some instances after the stock has been thoroughly beaten out, the emulsion may be pumped directly into the beaters and circulated with the stock until a uniform mixture is obtained; or an emulsion may be added in the stuff chest and likewise subjected to suitable agitation to provide a uniform mixture. I have generally found it preferable, however, to mix the emulsion with the fibre stock at the mixing box interposed between the machine chest and the screens. The proportion of emulsion to stock is readily controlled by valves on the delivery line or by usual metering devices and its introduction at this point facilitates rapid and easy variation of proportions. The mixture thus produced is preferably kept cold and passes through the screens and to the flow box of the machine whence it is formed into a sheet, exactly as if the stock contained no emulsion. A cold mixture produced by mechanical refrigeration, if desired, affects favorably the non-adhesive qualities of the emulsion and assists its resistance to pressure during sheet forming operation. The sheet or web is formed in the usual manner by felting or interlocking with the fibres on either cylinder or screen depending upon the type of machine, the sheet being successively subjected to the action of suction boxes, press rolls and after the desired amount of water is removed transferred in the usual way to the dryers. During the entire time and at all stages of the passage of the stock over the wet end of the machine, the asphalt particles retain their adsorbed films of water with protecting colloid to such an extent that the sheet or stock is at all times non-adhesive. Upon reaching the dryers, the residual moisture is gradually removed and the asphalt particles under the influence of heat and removal of adsorbed films of water gradually coalesce forming a more or less continuous phase throughout the sheet. When operating with a multi-cylinder machine, it is of course possible to vary the quantity and character of the emulsified asphalt in any of the plies; for example, the outer plies may be composed of ordinary rosin size stock free from asphalt, or may have introduced a colorable pitch while the body plies of the sheet may contain the usual quantity of black asphalt; likewise, under such conditions it is possible to use a softer asphalt of the same character in the body plies while employing a relatively hard and high melting point asphalt for the outer plies. It will be apparent that wide variations in character of the resulting product may be effected under such conditions producing thereby sheets which are particularly adaptable for special uses in which waterproof boards or heavy papers can be applied.

The product of this process is further characterized by the additional strength in the resulting sheet over that possessed when the stock itself is formed into a corresponding unsaturated sheet. The strength is increased almost directly in proportion to the amount of asphalt introduced. This affords an additional advantage in the roofing art wherein a product of this character containing less than the full saturation may be subsequently subjected to the usual process of tank saturation to take up additional amounts of asphalt and complete its saturation. A product of this character referred to, on account of its additional strength can be run through the machine with great rapidity and has the properties of absorbing additional saturation with great readiness.

It has heretofore been impossible to under-saturate or partially saturate a sheet of dry felt by tank method for the reason that saturation proceeds from the outer surfaces of the sheet and if the sheet is not permitted to take on its full saturation, it will be found that although the outer surfaces are completely saturated, the inner body of the paper may remain entirely free from the saturating liquid. A product of this process when incompletely saturated differs in this respect. The coalescence of the individual particles of asphalt and their ability to coat the individual fibres constitutes a novel feature of the behavior of the stock thus produced, on the driers. Even though the amount of asphalt maintained in the sheet be considerably less than that required to produce full saturation, the asphalt contained therein is

uniformly distributed throughout the body of the sheet as a more or less continuous coating upon the fibres. While this is true of the body of the sheet, I have found that the surface may under some conditions become more or less freed from the asphalt particles apparently as a result of their washing off or sucking from the surface as the web is being formed. In such cases, although the body of the sheet may contain the asphalt uniformly distributed throughout, the surface or superficial areas may show a mottled appearance due more or less to the removal of the asphalt as above described. In certain applications of this process, this affords a valuable feature of the invention, as for instance, in the case of floor coverings which are to be painted with a decorative coating. It has heretofore been found difficult in applying such paint coatings to ordinary saturated felt, to prevent the asphalt from becoming dissolved into the paint and discoloring it. The product of this invention, with a surface partially deprived of asphalt affords an ideal surface upon which to print with decorative paint.

I have described a drying operation as is usually carried on in connection with the cylinder or Fourdrinier type of machine in which a drying temperature is used above the boiling point of water and sufficient to cause complete coalescence of the individual particles of asphalt into a continuous film. I have found it possible, however, to conduct the drying operations in such a way that the particles of asphalt, especially when used in small proportions, may maintain their discrete form and serve the function of tying together and reinforcing the fibres and acting as a water repelling agent. For example, the product of this process produced on a wet machine may be dried in a drying room at a relatively low temperature and by proper selection of temperature with relation to melting point of asphalt employed, a dry sheet may be obtained in which the asphalt particles maintain their individual form, serving the purposes above described.

It will be further noted that the adhesive character of the asphalt is resumed during the drying operation and is attained only by the removal of water and by heat and without the use of chemicals or reagents to convert it to altered form. This result is accomplished by the purely physical means described.

I have discovered also that a valuable feature of the invention resides in the fact that the addition of the asphalt emulsion as before described to the paper stock, causes the fibres in their formation to be somewhat bulked; that is to say, the particles of asphalt seem to have the tendency to separate the fibres from each other to some extent during formation without interfering with the felting operation. When the sheet thus formed reaches the driers, and the asphalt particles begin to coalesce and spread themselves about the fibres in thin films, it is apparent that the spacing produced by their original position results in a sheet having greater void spaces; and being, in fact, bulked, it follows that the greater yardage of paper results from this bulking from a given quantity of stock. I have found in certain instances that this bulking has produced as much as 60% increase in area or yardage of paper over and above the quantity produced in the usual manner, from an equivalent weight of fibre stock.

In the preparation of saturated felt as for roofing fabrics, it has been the practice heretofore to employ felts or felted papers composed largely of rag fibres. This has been necessary for the reason that such felts only appear capable of saturation by immersion in the hot asphalt in a well known manner. The introduction of even small quantities of other paper stocks such as sulphate news or sulphite substantially retards saturation and it has heretofore been impossible to satisfactorily saturate felts composed of such stocks. By my process, however, all such limitations are obviated and I may readily use such stocks as heretofore have not been usable in tank saturated felts. These stocks are relatively cheap, and their use results in great economy over the production of saturated felts by heretofore known processes.

As an example of proportions used in the practicing of this invention, I take thirty parts by weight, of dry fibre stock which may be of any of the varieties of stock heretofore mentioned and mix with this, after beating out and while contained as a watery pulp, a mixture comprising fifty-eight parts of asphalt emulsified with twelve parts by weight, of clay contained in its aqueous vehicle. This proportion of components will produce a sheet which is practically completely saturated with asphalt and in character not readily distinguishable from tank saturated felt. A sheet of product derived from the above formula and in fact any product of this process, will upon extraction with suitable solvent for asphalt, leave a sheet of dry paper likewise indistinguishable from paper formed in the usual manner. While the proportions above stated produce a substantially saturated sheet, it is desirable in many instances and for many purposes to produce a sheet less completely saturated as for example for flooring felt, for wrapping papers, lining papers, shoe elements and the like. An example of the formula for partly saturated stock may be given as follows: to 50% of paper stock of dry weight is added an emulsion composed of 35 parts by weight of asphalt with 15 parts by weight of colloidal clay contained in its aqueous vehicle. This will produce a stock

suitable for damp proof papers and by proper selection of the paper stock constitutes a composition suitable for formation into shoe elements such as counters and the like. It should be noted as a novel feature of this process that the amount of asphalt and non-fibrous material which can be carried by the fibres without interfering with the felting operation may be more than twice the weight of fibres used. This I believe, constitutes a radical departure from any heretofore known practices of producing paper which permits of the introduction of so large a quantity of non-fibrous material without interference with the sheet forming or felting operation.

I have found that the use of this emulsion in stock has a tendency during formation of the web to close up the sheet and result in some difficulty when it is desired to produce a heavy caliper in a single ply. In such instances, I have found that the introduction of a small quantity of sawdust affords the necessary freeness to enable the sheet to be built into relatively thick calipers with easy removal of the water.

I claim as my invention:

1. A process of producing a waterproofed felted sheet, comprising mixing in water fibrous stock and a dispersion containing a heat liquifiable waterproofing material dispersed in an aqueous medium, regulating the proportions of fibrous stock relative to said waterproofing material so as to produce a sheet which is incompletely saturated with said waterproofing material, but in which said waterproofing material is substantially uniformly distributed in the form of substantially continuously coalesced films about the fibers, sheeting said stock, and drying the sheet.

2. A process of producing a waterproofed felted sheet, comprising mixing in water fibrous stock and a dispersion containing a heat liquifiable waterproofing material dispersed in an aqueous medium, regulating the proportions of fibrous stock relative to said waterproofing material whereby the fibrous constituents of the sheet so formed predominate, on the basis of weight, relative to the non-fibrous constituents, the waterproofing material being present in such an amount as to be substantially uniformly distributed about the fibers in the form of substantially continuously coalesced films, sheeting said stock, and drying the sheet.

3. A water resistant felted fibrous sheet containing waterproofing material distributed substantially uniformly about the fibers in the form of films, said sheet having the characteristics of having had waterproofing material incorporated during formation thereof and waterproofing material converted in the form of substantially continuously coalesced films, and further characterized in that the waterproofing material, on the basis of weight, is less than the fibrous stock.

4. An asphalt containing fibrous sheet having greater quantity, on the basis of weight, of fiber relative to asphalt, characterized by having had the asphalt incorporated therewith during formation of the sheet, said asphalt being distributed uniformly about the fibers in the form of substantially continuously coalesced films constituting an unbroken waterproofing medium.

5. An asphalt containing fibrous sheet, characterized by having had the asphalt incorporated therewith during formation of the sheet, said asphalt being distributed uniformly about the fibers in the form of substantially continuously coalesced films, said sheet being further characterized by containing a substantial amount of said asphalt, but less than the amount of fiber, on the basis of weight.

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