March 17, 1942. T. C. POND 2,276,869

METHOD OF MAKING A SHEET PRODUCT

Filed Oct. 30, 1937 2 Sheets-Sheet 1

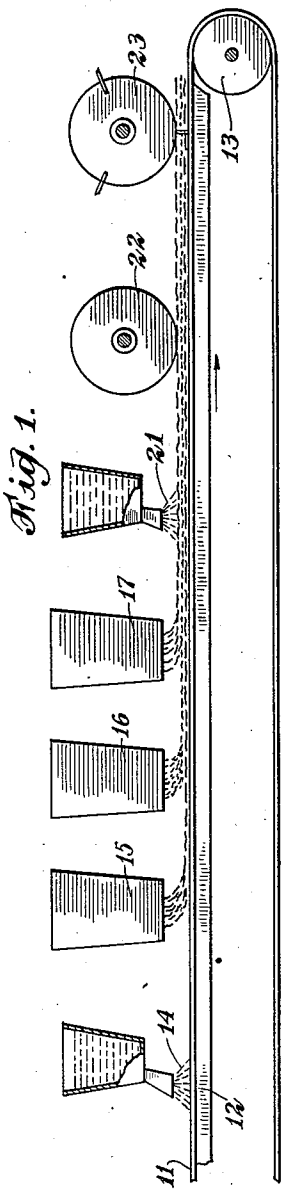


Fig. 1.

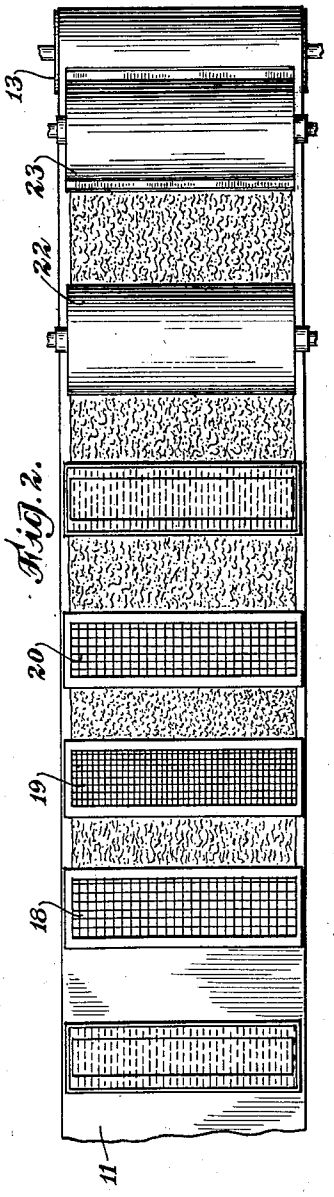


Fig. 2.

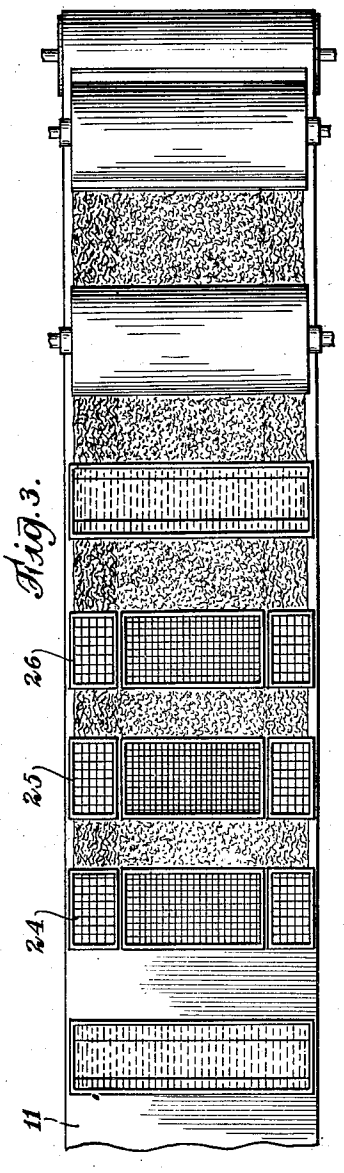


Fig. 3.

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Fig. 4.

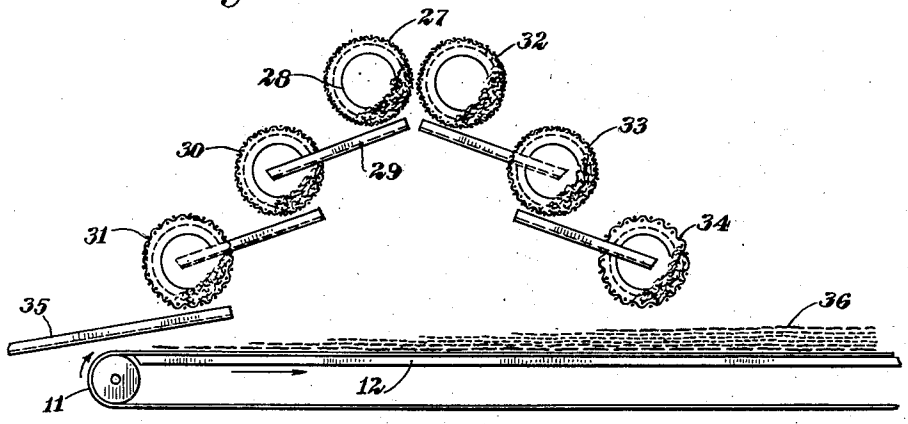


Fig. 5.

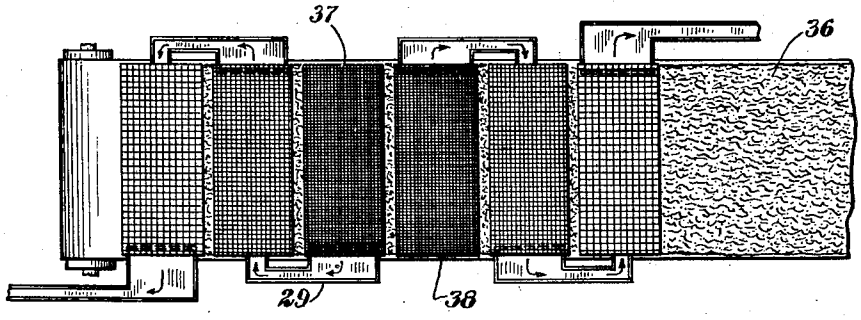
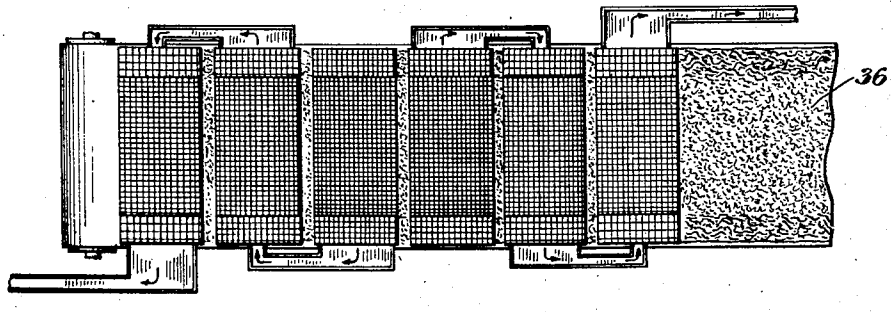


Fig. 6.



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2,276,869

METHOD OF MAKING SHEET PRODUCTS

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Application October 30, 1937, Serial No. 172,022

6 Claims. (Cl. 18—48)

This invention relates to an article of manufacture and the method and machine for making it.

More particularly, the invention relates to a fibre-reenforced sheet product in which the fibres are varied in proportion and/or in length in such manner as to provide the greatest strength in portions of the product in which greater strength is especially desirable.

While the composition of my product may be any one of several, as, for instance, one containing hemp, jute or shredded rag as the fibrous material and containing Portland cement, a high calcium aluminate cement ("Lumnite"), or gypsum plaster as the cementitious binder, the invention is particularly useful and will be illustrated in detail by reference to sheets composed largely of asbestos fibres and Portland cement. If other fibres or binder are used, they are substituted for the asbestos and Portland cement in the illustrative example of the invention herein described in detail.

In such a sheet subjected to loading, the sheet usually breaks first on the face that is under tension as the sheet bends. Also, such sheets frequently break at the edges, in handling, installation, or use.

In general, the preferred embodiment of the invention includes forming, one upon another, a plurality of layers of a mixture of the selected fibres and binder, the fibres being present in larger proportion and/or being of greater individual length in a layer forming an outside portion of the composite than in the adjacent portion of the article, applying water in excess to the materials constituting the composite, strongly compressing and consolidating the wet composite, and then hardening the binder therein. The invention comprises also the resulting product and machine for making it.

The invention will be illustrated by description in connection with the attached drawings, in which all of the figures are more or less diagrammatic and show variations from the standard processes and machines which in parts not illustrated are conventional.

Fig. 1 shows an elevational view of a machine for forming a sheet product.

Fig. 2 shows a view partly in plan and partly in horizontal section of the machine of Fig. 1.

Fig. 3 shows a similar view of a modification of the machine of Fig. 1.

Fig. 4 shows a side elevational view of a modified form of a portion only of the machine of Fig. 1.

Fig. 5 shows a plan view of the machine of Fig. 4.

Fig. 6 shows a view partly in plan and partly in section of a modified form of the machine of Fig. 4.

With reference first to Figs. 1 and 2 particularly, there are shown a felting member 11, such as a heavy cloth conveyer, moving in its upper reach over a flat supporting plate 12 and passing over end rollers 13, of which only one is shown.

Water is applied to the felting member at position 14, as from any suitable receptacle or spray equipment.

There is made an intimate dry mixture of asbestos fibres and Portland cement and this mixture is delivered by any suitable means, not shown, to the receptacles 15, 16, and 17 constituting screening members closed at their bottoms by screens 18, 19, and 20, respectively. Each of these screens extends across and above the felting member 11, so that asbestos and cement mixture passing through the screens falls upon the felting member, to form a plurality of layers arranged one upon another.

The screens are of different mesh openings, the screen of smallest mesh opening being the one to which the said mixture is first supplied, say, the central one, as illustrated, so that there is delivered from the screens 18 and 20 a mixture including relatively long asbestos fibres, and from the central screen 19 a mixture including shorter asbestos fibres. Furthermore, the proportion of fibres to cementitious material may be less in the mixture passing through the screen 19. As a result, therefore, there is not only classification as to length of fibres but also as to proportion, the central layer deposited below the screen 19 being more lean in fibre content and having its fibre content of lesser average length of individual fibres than the outer portions of the resulting composite.

Additional water is applied to the materials forming the composite, as, for example, at position 21.

The total water present in the materials on the felting member should be in excess, that is, more than enough to provide the water of hydration of the hydraulic cementitious material present, the excess being in part removed later by compression as will be described. On the other hand, the proportion of water should be not appreciably more than enough to make the wet mixture a shape-retaining plastic, readily shaped by compression.

The wet composite is smoothed by being passed

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under the roller 22 and is then cut into segments by passage under the cutter 23.

The segments from the cutter 23 are removed from the end of the conveyer at the right of Fig. 1, are stacked with alternating stiff metal or other plates, and are strongly compressed, as by a hydraulic press operating upon a stack of the alternating segments and plates several feet high and supplying a pressure of several thousand, as for example, two to eight thousand, pounds to the square inch. After the compression, the cementitious material is allowed to harden, as, for instance, under atmospheric conditions, for a month or so. The compressed sheets are separated from the intervening stiff plates described, as for example after hardening for at least ten days, and are trimmed to the exact dimensions desired for commercial use.

As the cementitious binder, there may be used a mixture of Portland cement and admixed silica, the hardening in this case being effected preferably by thorough steaming. The term "Portland cement" or "cementitious binder" includes such a mixture. Thus, there may be used a binder including, suitably, 30 to 100% of fine sand on the weight of the cement, the hardening being effected by subjecting the compressed wet material to saturated steam at a pressure of the order of 60 to 200 pounds to the square inch, for about two hours after the temperature becomes approximately uniform throughout the material, say 24 hours total.

To increase the capacity of the screens 18, 19, and 20, agitators (not shown) of a usual type may be installed in the containers 15, 16, and 17, to keep moving the mixture directly above the several screens. Also, over-size material that does not pass through the several screens may be removed from the receptacles when and as desired.

For those purposes making desirable classification of the fibre-cement mixture between the edges and the portion of the sheets therebetween, there may be used the screen members illustrated at 24, 25, and 26. These members include screens that vary, not only between the members that are displaced laterally with respect to each other, but also from end to end of any one screening member. Thus, each screen may contain relatively coarse end and finer central portions (with small mesh openings), so that, with these screens in use, there is a greater average length of fibres and also a greater proportion of fibres in the material deposited near the outer edges of the layer on the felting member 11 than in the central part of the layer.

In the machine illustrated in Figs. 4–6, the screening members are cylindrical and means (not shown) are provided for rotating them, so that they become tumbler or rotary screens. Also, the plurality of screens are displaced not only laterally with respect to each other, that is, in the direction of movement of the felting member 11 therebelow, but also vertically.

Preferably, the rotary screens are at least four in number and are of an even number, such as either four or six.

The mixed asbestos and cement composite is delivered to the rotary screen 27, which is at the highest elevation and which has the smallest mesh openings of any of the screens.

As this screen is rotated, it passes relatively fine material and gradually accumulates oversize material. This oversize material eventually rises above the end ring 28 and passes through the opening therewithin into the chute 29. This chute, in turn, delivers the material to the screen 30 of next highest location and next largest size of mesh openings. This screen, likewise, delivers its oversize material to screen 31. The screen 31 has the largest mesh openings, in fact, openings so large as to permit the passage therethrough of all but accidently coarse particles in the mixture. This coarse material is discarded through the chute 35.

Preferably the asbestos and cement mixture is supplied to the central two of an even number of screening members, so that there is the same order of movement throughout the screening members 32, 33, and 34, as previously described in connection with the members 27, 29, and 31. There is thus formed on the felting member 11 a material that is classified in like manner from both faces inwardly, with the longer fibres and the greater proportion of total fibre content in the two face portions of the resulting composite.

In the machine, shown in Fig. 4, parts to the right of the member 34 are suitably the same as parts of the machine that in Fig. 1 are to the right of the receptacle 17. The wetting, smoothing, cutting, compressing, and hardening are conducted as previously described.

The modification of this machine illustrated in Fig. 6 has larger mesh openings at the end portions of each individual screen than in the central portion thereof, so that there is classification giving predominantly longer fibres at the edges of the deposited felt 36 than in the central portions thereof.

The arrows in the various chutes of Figs. 5 and 6 indicate the direction of movement of the material in the chute. From these arrows it will be noted that the preferred direction of movement of the fibre-cement mixture in the double series of screens is opposite in any pair of tumblers of the same size of screen. Considering Fig. 5, for instance, the original asbestos and cement mixture will be supplied to screen 27 at the end 37 thereof and to screen 32 at the end 38 thereof. This oppositely directed flow in the two halves of the classifying equipment reduces undesirable variations that might otherwise be caused by the abrupt passage through the screens of a part of the mixture, say, the fine cement not retained by the asbestos fibres, at a position near that of first entrance into a screening member.

For some purposes, the original fibre-cement mixture may be supplied to the screen of finest mesh openings (27 and/or 32), at a position intermediate the two ends thereof.

Various proportions of the reenforcing fibres to the cementitious binding material may be used. In general, the overall proportions in the finished sheet may well be about the same as those which are now in use for sheets for any given purpose. Thus, the proportion of asbestos fibres may be 35 to 45 parts by weight to 100 parts of total weight for asbestos and cement siding units or 50 parts of asbestos to 100 total weight for sheets to be used as large panels for interior partitions. However, if the extra strength of my improved product is not necessary, the overall proportion of the fibres may be reduced, as for example, until the proportion of fibres in the faces of the sheet product is about that previously used throughout the entire thickness of the article.

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For good results as to strength, the average length of the fibres should be about that which is at present in use for sheets for the various purposes.

After the overall proportion and the average size of the fibres have been selected, there are chosen meshes of the several screens, such as those shown in Figs. 2–6, to give the approximate classification desired. For instance, the finest screen chosen may be one that will permit the passage therethrough of, say, a third to one-fourth of the total weight of fibres. The other screens selected should be larger in mesh openings, the largest screen having openings that will permit the passage of all of the well dispersed fibres. Satisfactory results are obtained if each of the several screens over which the mixture is successively passed (Figs. 4 and 5) permits the passage therethrough of approximately the same amount of the fibres, under operating conditions.

For mixtures including asbestos fibres of average fibre length, about that which is commonly used in asbestos and cement siding units, the screens used in the several screening members should vary from about two- to ten-mesh, the exact size of the openings selected being influenced not only by the wet screen test of the asbestos fibres present, but also by the thoroughness of agitation of the material in contact with the several screens, the mesh openings being larger if thoroughness of agitation is not obtained.

Preferably, I select the screens and operating conditions so that the asbestos fibres average about 25 to 100 per cent longer and/or are about 25 to 100 per cent greater in the ratio of weight of fibres to cement in the face portion than in the adjacent portion of the sheet product.

For instance, use of a fibre that averages about 10-mesh, in the standard wet screening test, will give by my method a product having fibres predominantly longer than 10-mesh in the face portion and shorter than 10-mesh in the adjacent portion.

As a modification of the general method of applying to a felting member a succession of layers of different proportion and/or length of fibres, there may be used the wet felting machine described in U. S. Reissue Patent No. 12,594 issued to Hatschek on January 15, 1907. In this machine and method there is first formed a dilute aqueous suspension of the asbestos fibres and Portland cement. A thin wet web is formed from this suspension on a moving felting member, such as a cloth conveyer belt, and the web is transferred to a rotating mandrel and built up thereabout into a felt of substantial thickness. The cylinder of felt on the mandrel is then severed lengthwise and the felt removed from the mandrel, straightened, strongly compressed and densified at a pressure of several thousand pounds to the square inch, and the cement is then hardened by being allowed to stand at atmospheric temperature for a month or so.

This conventional process of Hatschek is modified in the present invention, by changing the composition of the aqueous suspension from which the felt is formed, at different stages in the operation. The aqueous suspension used to form the web, which is wound upon the mandrel to give the first and last portion thereof, constituting the two faces of the finished product, includes fibres of average length and/or fibres of proportion to the cement that is greater than in the suspension used to form the central portion of the felt on the mandrel. In other words, the felting is begun with an aqueous suspension containing relatively long asbestos fibres and/or a relatively large proportion of them as compared to the proportion of cement, until a part, as for example an eighth to a third, of the total thickness of the felt has been built up on the mandrel. Then a change is made in the suspension, to a composition including shorter and/or a lesser portion of the fibres than previously used. Thus, the new suspension may be charged to the cylinder mold tank of the Hatschek machine, in place of the suspension first used. The felting is then continued until the felt is built up to approximately two-thirds to seven-eighths of the total amount of material desired therein. Then the same type of suspension is again used as was used at first, to make the last portion of the felt about like the first portion, in length of fibres and proportion of them.

The cylindrical felt on the mandrel is compressed during the winding operation of forming the felt, by the over-riding roller of the conventional machine. The compressed felt is hardened by allowing the cement to become hydrated. If a sheet product is desired, the cylindrical felt on the mandrel is severed lengthwise, removed from the mandrel, straightened, and repressed at very high pressure, before the cement is hardened.

Since all of the machinery used in this modified Hatschek or wet process is conventional, it is not illustrated.

In a modification of the general method described, screens **18**, **19**, and **20** may be omitted and compositions of the proportions and fibre length desired in the several portions of the finished product fed directly to the receptacles **15**, **16**, and **17** of Fig. 1 or spread in other convenient manner upon the felting member **11**. Thus, **15** and **17** may be supplied with a mixture including asbestos fibres in greater proportion and/or of greater average fibre length than the mixture supplied to **16**.

For some purposes also, it is sufficient if only the one face of the sheet product that is under tension, when supporting a load during use, is of higher modulus of rupture than the rest of the sheet. In such a case, members **17**, **32**, **33**, and **34** and accessory parts and operations pertaining thereto may be omitted. There is thus produced a sheet having greater strength in one face portion than in the adjacent portion. A similar result is accomplished when, using the wet felting machine of the Hatschek type, the change to the third composition (like the first) is omitted, and only two compositions are used for felting.

In making an asbestos and cement pipe in accordance with the present invention, the wet felt of varying fibre proportion and/or length is made on the mandrel and finished as described above with the following modifications: The mandrel selected has an external diameter approximately equal to the inside diameter of the pipe to be made and the felt wound therearound is strongly compressed during the winding operation. The wound tubular felt is not severed for removal from the mandrel; the felt is not straightened and the cement is hardened while the product is still in tubular form.

The details given are for the purpose of illustration, not restriction, and variations within the spirit of the invention are intended to be included in the scope of the appended claims.

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What I claim is:

1. In making a sheet product, the method which comprises forming, in turn, a plurality of layers, one upon another, including each an intimate dry mixture of fibres and a binder adapted to be hardened and including fibres of average length greater in the one of the said layers that is to constitute a face of the product than in the adjacent one of the said layers, applying water in excess to the materials forming the several layers, strongly compressing and consolidating the several layers, and then hardening the binder.

2. In making a sheet product, the method which comprises forming a dry mixture of asbestos fibres and a hydraulic cementitious material, classifying the mixture into portions graded roughly according to length of fibres, collecting each of the portions as a layer on a moving support so that the one of the said portions having the longest fibres therein is deposited first on the support and the one of the portions having the shortest fibres is deposited last, then repeating the classification process with a fresh supply of the mixture and collecting the classified portions in an order reversed from that first mentioned, so that the one of the portions containing the shortest fibres is deposited first upon the uppermost of the layers previously formed and the one of the portions having the longest fibres is deposited last, applying water in excess to the materials forming the several layers, strongly compressing and consolidating the wet materials, and then hardening the cementitious material therein.

3. In making a sheet material, the method as defined in claim 2, in which the mixtures are classified into portions so that the edge portions of each deposited layer contains asbestos fibres of greater length than the central portions of layers.

4. In making a sheet product, the method which comprises forming a dry mixture of asbestos fibres and a hydraulic cementitious material, classifying the mixture into portions graded according to the length of fibres, collecting each of the portions as layers on a moving support so that the edge portions include longer asbestos fibres than the central portions of the layers, applying water in excess to the material, strongly compressing and consolidating the layer of the wet material, then hardening the binder therein, and trimming the hardened material, so that an edge of the trimmed article is constituted predominantly of the mixture containing the longest asbestos fibres included in the mixture.

5. In making a sheet product, the method which comprises forming a dry mixture of asbestos fibres and hydraulic cementitious material, classifying the mixture with portions graded roughly according to length of fibres, collecting the portions as superimposed layers on a moving support so that the portion containing the longest fibres therein is deposited first and the portion containing the shortest fibres is deposited as a subsequent layer, then repeating the classification procedure with a fresh supply of a dry mixture of asbestos fibres and hydraulic cementitious material and collecting the classified portions, superimposed as layers on said first-named layers in an order reversed from that first mentioned, applying water to the materials forming the several layers, strongly compressing and consolidating the wet materials, and then hardening the cementitious materials therein.

6. In making a sheet product, the method which comprises forming a dry mixture of asbestos fibres and a hydraulic cementitious material, classifying the mixture into portions graded according to length of fibres, collecting the portions as superimposed layers on a moving support so that the edge portions include longer asbestos fibres than the central portions of the layers, applying water to the material, strongly compressing and consolidating the layer of the wet material, then hardening the binder therein, and trimming the hardened material, so that an edge of the trimmed article is constituted of a mixture containing longer asbestos fibres than the central portion of the individual layers.

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