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1,988,340

PROCESS AND APPARATUS FOR MAKING LAMINATED VULCANIZED FIBER

Original Filed April 25, 1929 2 Sheets-Sheet 1

Fig. 1.

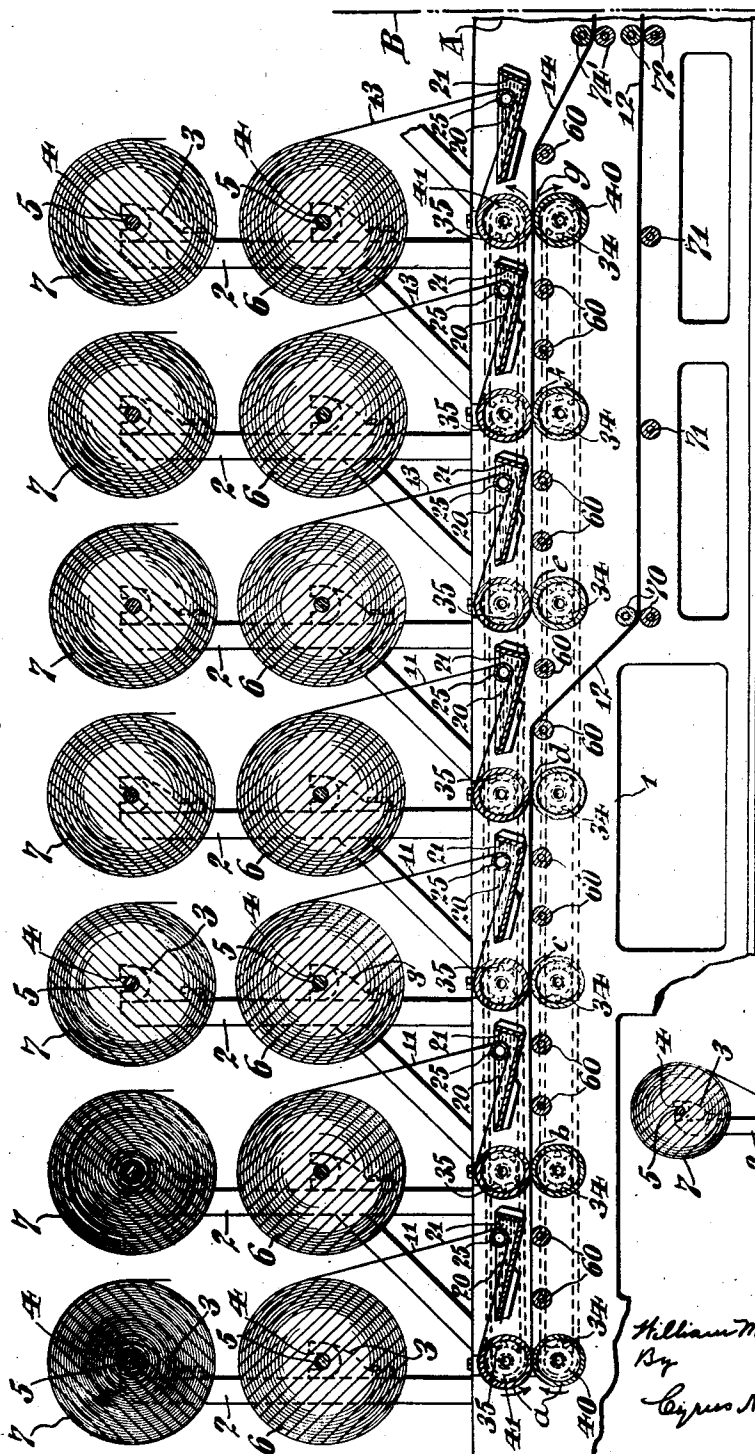
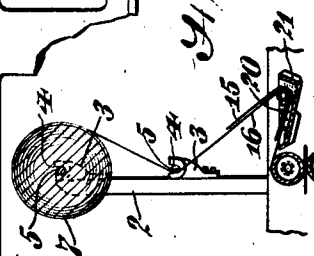


Fig. 5.



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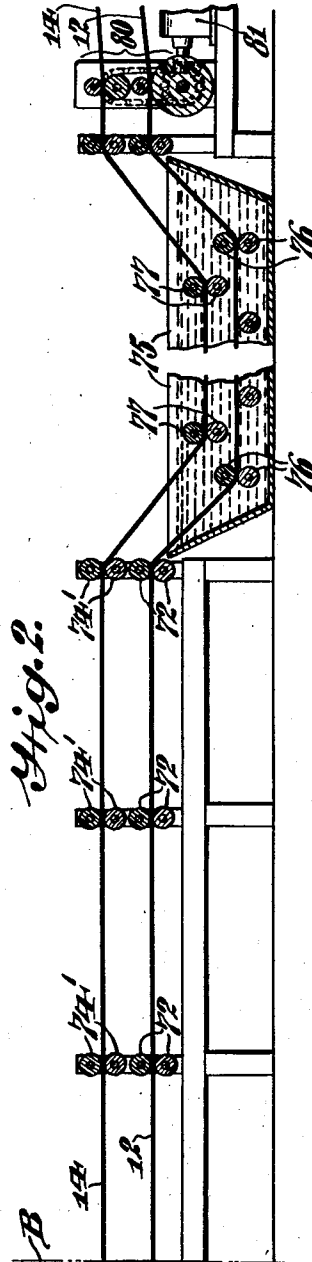
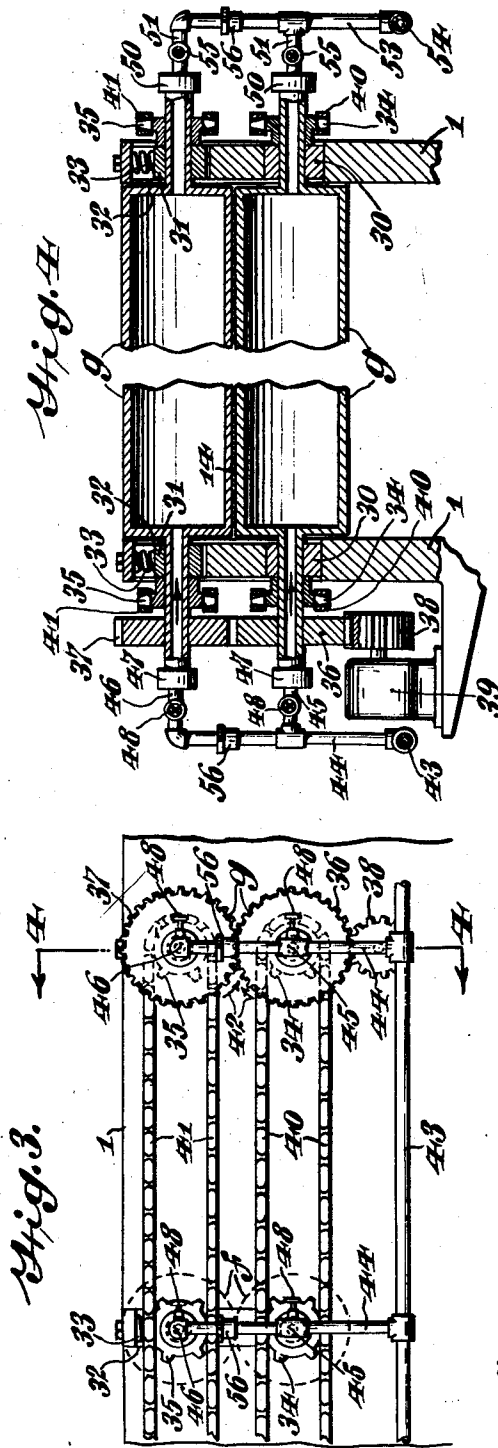
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UNITED STATES PATENT OFFICE

1,988,340

PROCESS AND APPARATUS FOR MAKING
LAMINATED VULCANIZED FIBER

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Continuation of application Serial No. 357,971,
April 25, 1929. This application February 15,
1930, Serial No. 428,580

15 Claims. (Cl. 154—34)

The present application is a continuation of
application Serial No. 357,971 filed April 25, 1929.

My invention relates to the manufacture of
indurated fiber. As exemplified by Patent No.
5 897,758 to Marshall and Patent No. 1,675,666 to
Shoemaker, this type of material has heretofore
been made by passing several webs or sheets of
cellulosic material, preferably but not necessarily
an all cotton cellulose paper, through a gelatin-
10 izing or parchmentizing bath of suitable concen-
tration and temperature and then combining or
laminating said gelatinized or parchmented
webs or sheets into one multi-ply web or sheet
by the means of suitably applied heat and pres-
15 sure. Among the parchmentizing or gelatinizing
agents that have been mentioned in the prior art
are included aqueous solutions of metallic salts
such as zinc chloride and dilute acids such as
sulphuric. These agents serve to chemically hy-
20 drate, partially hydrolyze or gelatinize the cellu-
lose fiber of the individual sheets, thus enabling
them to coalesce and become indissolubly united
or welded into a more or less homogeneous multi-
ply sheet under the subsequent application of
25 heat and pressure. By leaching and purging out
the treating agent and subsequently drying the
sheet, a hardened material results having greatly
improved characteristics as compared with the
cellulose webs originally subjected to the chemical
30 and physical treatment. The term "vulcanized
fiber" is usually applied in the art to indurated
material which has been made by the use of a
solution of a metallic salt such as zinc chloride
while the term "leatheroid" is usually reserved for
35 material which has been made with a dilute acid
such as sulphuric.

In the following description and claims the
term "paper" is to be used in its ordinary signifi-
cance in the art; namely, a sheet of cellulosic
40 material from whatever source or sources derived.
The terms "fiber", "vulcanized fiber", "indurated
fiber" and "leatheroid" are used interchangeably
to mean a cellulosic material treated by means
of chemicals (herein referred to as "gelatinizing
45 agent" or "gelatinizing bath", etc.) to impart
thereto a hardness and density not ordinarily
possessed by untreated paper.

An important object of my present invention
is to provide a new and improved method and
50 apparatus whereby a continuous sheet or web
of indurated fiber may be produced of greater
thickness than has previously been accomplished
or considered practical.

The essence of the portion of the combination
55 hereinafter to be described which renders the

foregoing object possible of accomplishment is
the provision of means for the separate impreg-
nation and heat and pressure treatment of each
individual web which enters into the make-up
5 of the final product. According to one of the
prior art methods, it was the usual practice to
subject a plurality of separated webs to the action
of one and the same gelatinizing bath and then
to superpose the webs and conduct them over,
10 around and between cylinders which provide the
requisite heat and pressure to combine the sep-
arate webs into one integral, multi-ply product.
This prior art process is necessarily limited in
the number of webs which it can chemically treat
15 and laminate due to the fact that the heat can
reach all the webs only by conduction through
the entire thickness of the product. Furthermore,
the process is very slow, particularly due to the
fact that the pressure which consolidates the
20 sheets must at the same time force the excess
gelatinizing agent from between all the webs
to the edges in order to eliminate it from the
product. I have discovered that by treating the
constituent webs individually instead of as in
25 the prior art, a larger number of webs can be
treated and consolidated into the final product.
The heat has to strike through only one web at
a time and likewise the excess gelatinizing agent
has to be expelled from only one web at a time.

Another object is to provide a new and im-
proved method and apparatus for producing a
laminated or multi-ply web of indurated fiber
having a greater homogeneity and density than
had previously been possible.

The essence of the portion of the combination
35 hereinafter to be described which renders the
foregoing object possible of accomplishment is
the provision of means whereby the conditions
under which each individual sheet is chemically
treated and subjected to heat and pressure may
40 be selectively controlled or varied. As is known
in the art, paper of different basic stock, density,
absorption, etc. may require treating solutions
having different concentrations, temperatures,
purity, etc. to produce products having desired
45 properties. For instance, a dense, highly calen-
dered paper requires treatment with a more fluid
agent indicated by a lower Baumé. Also, a highly
calendered or low absorption "hard" paper is
more difficult to treat with agents above certain
50 temperatures. By means of my invention it is
possible to control or vary the treating and lami-
nating conditions for any one or more of the in-
dividual webs without necessarily affecting the
55 conditions for the other webs. Thus I have found

it possible for the first time to produce a multi-ply web of indurated fiber under optimum conditions of concentration, temperature and state of purity of reagent as well as temperature and pressure of lamination.

Another object is to provide a new and improved method and apparatus by means of which may be produced a multi-ply web of indurated fiber from a very soft, open, absorbent paper.

The essence of the portion of the combination hereinafter to be described which renders the foregoing object possible of accomplishment is the compactness with which I have arranged the various elements of the apparatus in reference to the individual webs which enter into the fabrication of the multi-ply web of indurated fiber. Prior processes and apparatuses have invariably required the unbatching or unwinding of the rolls of paper from considerable distances and then the dipping or immersion of the individual plies through the treating agent and the lifting or drawing of the individual webs, heavily weighted with the excess treating agent up from the bath over and around the drums or cylinders by means of which the heat and pressure necessary for the laminating step are to be applied. It has, therefore, been impractical to utilize a very open paper or felt such as would naturally lack the tensile strength necessary to permit it to be drawn through the bath and then to be raised and conducted to the drums or cylinders. In my apparatus the paper is unwound in close relation to the treating bath and has a relatively short, almost horizontal, travel to the heat and pressure applying cylinders. Thus it is rendered practical to use a paper or felt of greater softness, openness and absorption and lower tensile strength than had previously been considered possible.

Still another object is to provide a new and improved method and apparatus having great flexibility of operation, whereby one or more webs of any desired number of plies may be produced.

The essence of the part of the combination hereinafter to be described which renders the foregoing object possible is the provision of means for leading the laminated web or webs of indurated fiber off at any one or more selected positions along the apparatus.

A further object is to provide a new and improved method and apparatus by means of which a laminated web of indurated fiber of great thickness may be continuously produced at a greatly increased rate (speed in lineal feet per minute).

The essence of the part of the combination hereinafter to be described which renders the foregoing object possible of accomplishment is the portion of the process and apparatus whereby each individual web but the first is separately superposed upon and combined by the means of heat and pressure with a web of progressively increasing thickness which has already been subjected to the consolidating action of heat and pressure. As has already been pointed out, when a plurality of chemically treated webs are superposed and combined over, around and between drums or cylinders as in the prior art, the process is necessarily slow (five to fifteen lineal feet per minute) due to the fact that the heat must be conducted through all the webs and to the further fact that the excess treating agent must be forced from between all the webs at the same time. In the process and apparatus of the present invention, the heat and pressure are first applied to the first web to form a base web and then to each individual web separately and suc-

cessively as it is laid upon and is consolidated with the previously consolidated web or webs. Hence, the heat has to be conducted through only one web at a time and the excess treating agent expelled from only one web at a time. Thus, it has been found possible to speed up the process to as high as fifty lineal feet per minute.

A further object is to provide a new and improved method and apparatus by the means of which a laminated product of indurated fiber may be produced in which all the plies are of exactly the same length.

The essence of the part of the combination hereinafter to be described which renders the foregoing object possible of accomplishment is the superposing and consolidation of the constituent webs in a level or flat plane as opposed to the curved surfaces of the prior art. In the prior art there are two general methods of producing a laminated web of indurated fiber. The first method consisted in winding a single layer of gelatinized paper around a drum and upon itself until the desired thickness was obtained. The sheets are then produced by stripping and cutting the laminated material from the drum. Naturally, the ply which had been wound on the drum first is of shorter length than the others and when the stripped material is flattened out, strains are set up in the material which produce an undesirable warping in the dried material. The second general method of the prior art consisted in continuously laminating a plurality of treated webs of indefinite length by conducting the superposed webs over, around and between heated drums or cylinders. Since the superposed webs dry and set while in a curved condition, a warping tendency is produced in the final product. In my invention, each of the constituent webs are of exactly the same length due to the fact that the consolidation of the webs is carried out while they are maintained in flat condition. Thus, the warping tendency so characteristic of the prior art product is entirely eliminated.

A further object is to provide a new and improved method and apparatus by the means of which a laminated web of indurated fiber may be produced having either no selvage or a minimum of selvage, thus reducing waste to a minimum.

The essence of the part of the combination hereinafter to be described which renders the foregoing object possible of accomplishment resides in the arrangement of the supply rolls of paper in relation to each other and to the finished web of indurated fiber as it is being formed so that the individual webs may be withdrawn from their supply rolls and superimposed with their edges in exact alinement or flush relation to each other and to the laminated web. The supply rolls are independently mounted on the machine so that they may be readily adjusted axially or laterally in respect to the apparatus.

A still further object of the invention is to provide an apparatus for the formation of multi-ply webs of indurated fiber, in which the source of supply for any one or more of the constituent webs of the laminated product in process may be replenished without interrupting the process.

The essence of the part of the combination to be hereinafter described to which can be attributed the foregoing object is the provision of at least two sources of supply for each one of the constituent webs of the laminated product, in operative relation to the gelatinizing baths, so that

whenever one source is exhausted the second can be drawn upon without interrupting the continuity of the process.

Other objects and advantages of the invention will be set forth as the detailed description thereof proceeds or else will become apparent from such description. In order that the invention may be understood readily and the advantages thereof more fully and easily appreciated, reference should be had to the accompanying drawings, wherein I have illustrated a mechanical embodiment of an apparatus in the form at present preferred by me.

In the drawings:

Fig. 1 is a view in longitudinal section of a portion of an apparatus embodying the invention; Fig. 2 is a similar view showing an additional or extended portion of the apparatus;

Fig. 3 is a view in side elevation of a fragmentary portion of the apparatus;

Fig. 4 is a transverse sectional view taken on the line 4-4 of Fig. 3; and

Fig. 5 is a sectional view in reduced size of a fragmentary portion of the apparatus indicating a feature of operation which is practicable in an apparatus embodying the invention.

In the drawings I have shown a portion of the structure in Fig. 1, the broken line at A indicating that the structure as shown in that figure may be extended indefinitely, within practical limits, and the dash-and-dot line B indicating the plane within which the righthand end of Fig. 1 terminates and that within which the lefthand end of Fig. 2 begins. The showing is made in this way because it is not practical to show satisfactorily in a single figure the apparatus in its full length.

The portion of the structure illustrated in Figs. 1, 3 and 4 comprises a frame having a base or supporting portion, indicated as a whole at 1, from which rise upright posts or standards 2, which posts are arranged in couples, one post of each couple being located at one side of the base and the other post of said couple being located at the opposite side of said base. These posts are each provided with brackets 3 which are secured to one side thereof as indicated in Fig. 1. These brackets are provided with notches, as indicated at 4, which notches constitute bearings in which the opposite ends of the mandrels 5 are supported. These mandrels support rolls of paper 6 and 7. As will be apparent, these mandrels and the rolls carried thereby are supported independently of each other, and any roll and its mandrel of the top series may be removed without disturbing any other roll of the series or any one of the rolls 6 of the lower series. However, when all of the rolls are full, as indicated in Fig. 1, it is obvious that none of the rolls 6 of the lower series (except that at the righthand end of the series) may be removed without first removing one or more rolls 7 of the top series.

In the construction as shown, the paper webs are illustrated as being drawn from the bottom series of rolls 6. There are shown in each series seven rolls of paper. The webs of paper, which for convenience of description I shall designate by the reference numeral 11, which are drawn from the first four rolls 6 (counting from the left of Fig. 1) of the bottom series are united to form a single four-ply web or sheet 12, while the webs 13 drawn from the last three rolls 6 of the bottom series are united to form a single three-ply web 14.

As has been indicated already, the base 1 may be made of such length as may be desired, and

there also may be such number of pairs of posts 2 as may be necessary to supply the number of plies of paper which it is desired to employ in the making of a vulcanized fiber sheet or web; or the number of pairs of posts employed may be such as to provide the rolls necessary to supply the number of sheets required in the production of a plurality of vulcanized webs of fiber, in the manner as illustrated in the drawings.

While the rolls 6 and 7 are located in series one above the other, as illustrated in Fig. 1, and each roll is supported independently of the other, it will be apparent that when the paper from a roll 6 or the rolls 6 is exhausted the operation may be continued without interruption by thereafter taking the paper from the roll 7 or the rolls 7 of the top series. Assuming that the paper has been unwound from a roll, and that the rear end portion thereof, as indicated at 15, has passed from the mandrel 5 of such roll, as indicated in Fig. 5 of the drawings, it will be seen that the paper may then be taken from a roll 7 in the top series located directly above that from which all of the paper has just been removed. Preferably the forward end of the paper from the top roll should be carried down on the left side of the mandrel 5 and placed in overlapping position, as indicated at 16, with relation to the rear end portion 15 of the paper of the bottom roll. The two plies are fed forward in overlapping relation, as indicated, and are caused to combine and adhere together as the process continues. It is preferable that the ply of paper from the top roll should be carried down on the lefthand side of the mandrel 5, so that the latter may be more readily removed from its bearings. After the removal of the latter from its bearings the mandrel of the top roll is removed from its bearings and lowered into the lower bearings, whereupon a new roll may be placed in the top bearings, thus providing practically at all times a supply of rolls in the top series from which the paper may be taken after it has been removed from the rolls of the lower series. By this means an uninterrupted continuation of the operation may be practiced.

The webs of paper taken or withdrawn from the rolls are conveyed through solutions of zinc chloride or such other substances as may be employed, indicated at 20, and held in the containers 21 supported successively or in series and in proper relation to the respective rolls of paper of either the top or bottom series. The solution of zinc chloride in these containers should be of suitable strength, say about 70° Baumé, and of a temperature which may range from room temperature to about 35° C. The solution held in the containers 21 preferably consists of a water solution of zinc chloride, as hereinbefore indicated. In order to guide the webs of paper through the solution held in the said containers 21 I have provided guides 25 supported at their opposite ends upon the opposite sides of the said containers, which guides may be stationary or rotatable. The bottom portion of each of these guides is located a distance above the bottom of the container in which it is located so as to permit the webs of paper 11 or 13 to travel underneath the same and thereby be caused to pass through the solution held in the said container. Each of the containers is associated and cooperates with a couple of pressure and heat-applying rollers, which may be described as being located in front thereof. These heat-applying rollers may be of the same diameter, as shown, or, if desired, the diameter of the top roller may be increased so that it will be greater

than that of the lower roller. In such event it should be rotated so that the speed of movement of its surface would be the same as that of the surface of the lower roller of smaller diameter. By so increasing the diameter of the top roller of a pair of rollers the period of time during which heat is applied to a web or ply of paper may be increased.

The front of the machine will be regarded as that end which is located at the lefthand side of Fig. 1 of the drawings.

By the construction as illustrated, in which a stationary guide or single guide 25 is provided for each of the containers 21, it is possible to make the said guides of greater diameter than has been practical in the apparatus of this character heretofore employed in the manufacture of vulcanized fiber board.

The heat and pressure-applying rollers are arranged in couples, which couples are designated respectively by the letters *a, b, c, d, e, f*, and *g*. The couple of rollers *a* is the first of the series of couples of rollers and it is located to the left of the first of the containers 21. It will be noted that the webs of paper 11 and 13 after they have passed underneath and beyond the guides 25 are inclined upwardly and extend in parallel relation to the inclined bottoms of the containers 21. Referring to the first of the webs 11, it will be noted that it passes over the top of the upper of the couple of rollers *a* and around approximately one half portion thereof, and then backwardly in reverse direction between the two rollers, and thence the said web travels rearwardly and passes in succession between the rollers of the successive couples of rollers *b, c* and *d*. The web of paper which is taken from the second of the rolls 6, as illustrated, travels through the solution of zinc chloride contained in the second of the containers 21, and thence over the top roller of the couple of rollers *b* and around approximately half of the said roller and backwardly or in reverse direction between the rollers of the said couple. It is apparent that at this point the first and second webs 11 are united into a two-ply sheet or web. The same operation takes place with respect to the remaining two webs 11 shown in Fig. 1, the said webs being united successively by means of the two couples of rollers *c* and *d* with the previously united first and second webs 11, as illustrated in Fig. 1. In like manner the webs designated by the reference number 13, which are the last three webs shown in Fig. 1, are united.

For the purpose of completing the gelatinization and causing the union of the webs which are brought into overlying relation with respect to each other as described and as illustrated in Fig. 1 of the drawings, the rollers of the respective couples *a, b, c*, etc. are heated. The heating thereof may be effected in any desired known manner but I prefer to effect the heating thereof by the introduction thereinto (the said rollers being tubular as shown) of a suitable heated fluid, such as water or steam. The temperatures to which the said sheets may be raised by the action of the heat of the rollers of the couples *a, b, c*, etc., may range from about 38° C. to about 93° C., and the heat of the fluid supplied to the respective rollers of the couples may be governed accordingly. Except for their rotation the bottom rollers of the respective couples *a, b, c*, etc., are stationary, being journaled in stationary bearings 30 mounted in openings provided in the opposite sides of the base 1. The top roller of each

of the couples is movable vertically, being supported in bearings 31 which are mounted in notches or slots 32 provided in the upper portions of the opposite sides of the base 1. Springs 33 bear upon the said bearings 31 and hold or tend to hold them downwardly so as to cause the top roller of each of the couples to bear against the bottom roller of each of said couples or upon a sheet or web of paper or fiber board which may be passing or traveling between the said rollers. The trunnions by which the rollers of the respective couples are supported upon the bearings 30 and 31 are hollow and they are also extended as indicated in Fig. 4, and are provided with sprocket wheels indicated at 34 and 35. The extended journals of the rolls of one couple, as indicated in Figs. 3 and 4, are provided with gears 36 and 37 which mesh with each other as shown. The gear 36 is also in engagement with a pinion 38 mounted upon one end of the shaft of a motor 39. Of course power for driving the pinion 38 may be supplied in any other way or from any other source. The driving of the pinion 38 causes rotation of the gear 36, which in turn causes rotation of the gear 37. These gears being connected to the journals of a couple of rollers as illustrated in Figs. 3 and 4, the said rollers are likewise rotated. For the purpose of effecting rotation of the rollers of all of the couples of the series the journals of the rollers of each couple are provided with sprocket wheels 34 and 35 which are adapted to be engaged by sprocket chains 40 and 41. It may be noted that the gears and the rollers are rotated in the direction indicated by the arrows 42 in Fig. 3. The rollers of the remaining couples are rotated in like or similar directions. For the purpose of supplying heated fluid, such as water or steam, to the hollow rolls of the respective couples of rolls, I have provided a manifold pipe 43 which extends lengthwise of and in adjoining relation to one side of the apparatus, from which manifold branch pipes 44 extend, which pipes are connected by means of laterally extending sections of pipe 45 and 46. These sections of pipe 45 and 46 are connected by means of couplings 47 to the outer ends of the journals of the rollers of the respective couples. For the purpose of controlling the admission of heated fluid to the hollow rollers of the respective couples I have provided valves 48 in the sections of pipe 45 and 46. These valves are shown in Fig. 4 of the drawings. The journals at the opposite ends of the rollers are also hollow and are connected by means of couplings 50 with the ends of sections of pipe 51 which in turn are connected to branch pipes 53 having connection at their lower discharge ends to a manifold pipe 54 by which the fluid which has passed through the hollow rollers is or may be conveyed away. The branch pipes 51 are also provided with valves 55 which are adjustable to control the passage of fluid through the said branch pipes. By properly regulating these valves the rate of flow of the heating fluid through the hollow rollers of the respective couples may be controlled and by such control the temperature of the said rollers may be regulated and controlled. In order that vertical movements of the topmost rolls of the respective couples may be permitted I have made the branch pipes 44 and 53 in two parts, the adjoining ends of the said parts being connected by means of slip joints, indicated at 56, having packing therein, in known manner, to prevent escape of the heating fluid as it enters and leaves the top rollers of the respective couples of rollers *a, b, c*, etc.

The employment of sprocket chains 40 and 41 to rotate the rollers of the respective couples causes rotation of all of the rollers at the same rate of speed. It will be understood, however, that if desired, means may be provided whereby the bottom rollers may be caused to rotate at a slightly greater speed than the top rollers, or on the other hand, it may be provided that the top rollers shall rotate at slightly greater speed than the bottom rollers. However, the rollers usually are and should be caused to rotate at the same speed, as is indicated in the drawings.

For the purpose of supporting and aiding in the rearward travel of the web between the adjoining couples of rollers in the series I have provided intermediate rollers 60 of relatively small diameter, the upper sides of which are located in a plane tangential to the upper sides of the bottom rollers of the respective couples. That relationship is clearly apparent from Fig. 1 of the drawings. Preferably the rollers 60 should be caused to rotate at a speed sufficient to cause their peripheral surface to travel at the same speed as the speed of travel of the peripheral surfaces of the rollers of the respective couples *a*, *b*, *c*, etc.

In its passage between the rollers of the couple *a* the first of the webs 11 is not only subjected to heat but also to pressure, whereby its gelatinization is accelerated and its density and homogeneity of structure increased. As it passes between the rollers of the couple *b* it is joined by and united with the second of the webs 11 and both of the said webs are subjected to heat and pressure by the rollers of the couple *b*. In like manner the third and fourth webs 11 are united with the previous webs and with each other by the action of the rollers of the respective couples *c* and *d*. The location of these couples of rollers in succession as shown enables a successive kneading of and compressing action upon the webs of paper, so that a product having improved characteristics of density and homogeneity is produced. One reason why the product resulting from the operation is of improved character is that each of the webs is subjected to the full action of the heat and pressure of the top rollers of the successive couples of rollers. The arrangement and the operation are such also that there is no practical limit to the number of webs which may be united. In other words, the apparatus provides means whereby sheets of vulcanized fiber of greater thickness of required quality may be made than heretofore has been practical. In like manner the couples of rollers *e*, *f*, and *g* operate to form a three-ply product 14 by effecting union of the three webs 13 of the last three rolls of the bottom series of rolls. It will be understood also that the operation is identically the same if the webs of paper should be taken from the topmost series of rolls 10.

While I have shown products of four-ply and three-ply, respectively, it will be apparent that a single product may be produced having a thickness equal to the combined thickness of a number of sheets of vulcanized fiber, and by extending the apparatus as is indicated at *A* may be done, a greater number of rolls 6 and 7 may be supported from which paper may be taken, and consequently an added and indefinite number of sheets of vulcanized fiber may be produced simultaneously or else a single sheet having a thickness equal to the combined thickness of the plurality of sheets may be produced.

The four-ply sheet 12 is conducted from the first of the rollers 60, which is located between

the couples of rollers *d* and *e*, downwardly between the pair of rollers 70 and over the rollers 71 by which it is supported, and thence between the pairs of rollers 72, from the last of which it is conducted through one or more tanks, one being shown at 75, containing zinc chloride in more dilute solution in water than that held in the containers 21. Likewise the sheet or web 14 previously referred to is conducted between pairs 74' of rollers from the last of which it is conducted to the same tanks as those through which the sheet 12 is conducted. The sheets 12 and 14, respectively, are guided through the tank 75 by means of pairs of rollers 76 and 77 and are guided therefrom by means of pairs of rollers 78 and 79. To aid in causing the vulcanized fiber webs to travel rearwardly through and from the machine I have provided drawing rollers, indicated as a whole at 80, the said rollers being driven by means of a motor a portion of which is indicated at 81.

After having passed through and beyond the solution contained in the tank 75, or additional tanks if any be employed, the sheets are subjected to the usual purging process.

The purpose of passing the sheets through one or more tanks of a relatively dilute solution of zinc chloride in water is to remove therefrom the strong zinc chloride from the surface of the sheets which was deposited thereon in the passage of the sheets through the relatively strong solution held in the containers 21. By thus partially removing the strong zinc chloride from the surfaces of the sheets they will not take up stain or become discolored from the subsequent "purging" operation, nor will the sheets stick together if cut into individual sheets and laid one upon the other to make up a truck-load, as actually may happen in practice.

The foregoing constitutes the essential and distinctive thought of my improved process and the apparatus by means of which I prefer to carry out its steps, but it will be, of course, understood that the same may be combined with various other steps or details without affecting the peculiar results obtained. Furthermore, that changes and modifications may be resorted to without departing from the spirit of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. An apparatus for producing a multi-ply web of vulcanized fiber, comprising means for supporting in adjoining relation to each other a series of rolls of paper, a separate container located laterally of the respective rolls of paper, which container is adapted to hold gelatinizing agents of the same or different concentrations and temperatures and each container having means whereby a web of paper taken from the adjoining roll may be guided through the gelatinizing agents contained therein, pairs of rollers located in advance of the respective containers, the rollers of each pair being located one above the other and the top roller adapted to rest upon the bottom roller and the web of paper which passes through the adjoining container being conducted over the topmost roller and between the two rollers whereby heat and pressure are applied thereto, the web of paper from the first of the rolls of paper passing between the rollers of all of a selected number of pairs of rollers and the webs of paper from succeeding rolls passing between the rollers of a number of couples one less than the number between which the next preceding web of paper passes, and means for 75

conveying the sheet produced by the union of the said webs from the said apparatus.

2. An apparatus for producing a multi-ply web of vulcanized fiber, comprising means for supporting a plurality of rolls of webs of paper in adjoining relation to each other, a container located laterally of and below each roll which containers are adapted to contain gelatinizing agents of the same or different concentrations and temperatures, means located within each of said containers for contacting with and guiding the webs of paper from the said rolls through the gelatinizing agents contained in the said containers, a couple of rollers located in advance of each container, which rollers are located one above the other and the top roller exerting pressure upon the bottom roller of each couple, the webs of paper after having passed through the solutions held in the respective containers passing over and partially around the topmost of the rollers of each couple and being extended rearwardly between the said rollers, the said webs of paper being brought successively into contact with each other at uniform distances along the composite sheet, and union thereof successively effected by heat and pressure applied thereto by the rollers of the said couples.

3. An apparatus for producing a multi-ply web of vulcanized fiber, comprising means for supporting a plurality of rolls of webs of paper in series, containers located laterally of and below the respective rolls of paper which containers are adapted to hold gelatinizing agents of the same or different concentrations and temperatures, and each container having means therein for contacting with and guiding a web of paper therethrough from the adjoining associated roll of paper, couples of rollers located in advance of and in cooperative relation to the respective containers, the upper roller of each couple resting upon the lower roller of the couple, means for heating the said rollers and the webs of paper after leaving the respective containers, the said webs passing over and partially around the top roller of each of the couples of rollers and the said webs passing between the said rollers and thence toward the rear of the apparatus, the webs from successive rolls of paper being successively united with paper from the preceding rolls of paper at predetermined distances along the composite sheet thus formed, such union being effected by the application of heat and pressure to the said sheets by the said rollers, and means for conveying the sheets produced by the combining of the said webs of paper away from the sheet-forming portion of the said apparatus.

4. A method of making a multi-ply web of indurated fiber which comprises the steps of subjecting a web of cellulosic material to the action of a gelatinizing bath of desired concentration and temperature, subjecting said web to the action of heat and pressure to carry its gelatinization sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber, subjecting a second web of cellulosic material to the action of a gelatinizing bath of desired concentration and temperature which are not necessarily the same as those of the first bath, superposing the second treated web upon the first and subjecting the superposed webs to the action of heat and pressure to carry the gelatinization of the second web sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber and to si-

multaneously unite said webs into a single dense homogeneous web of indurated fiber.

5. A method of making a multi-ply web of indurated fiber which comprises the steps of subjecting a web of cellulosic material to the action of a gelatinizing bath of desired concentration and temperature, subjecting said web to the action of heat and pressure to carry its gelatinization sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber, subjecting a second web of cellulosic material to the action of a gelatinizing bath of desired concentration and temperature which are not necessarily the same as those of the first bath, superposing the second treated web upon the first, subjecting the superposed webs to the action of heat and pressure to carry the gelatinization of the second web sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber and to simultaneously unite said webs into a single dense homogeneous web of indurated fiber and continuing the process with as many additional webs of cellulosic material as necessary to build up a web of indurated fiber of desired thickness.

6. An apparatus for producing a multi-ply web of vulcanized fiber comprising the combination of means to subject a web of cellulosic material to the action of a gelatinizing bath, means to subject said web to the action of heat and pressure to carry its gelatinization sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber, means to subject a second web of cellulosic material to another gelatinizing bath, means to superpose said two webs, and means to apply heat and pressure to the superposed webs to carry the gelatinization of the second web sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber and to indissolubly unite the two webs into one dense, homogeneous multi-ply web.

7. An apparatus for producing a multi-ply web of vulcanized fiber comprising the combination of means to subject each of a plurality of webs of cellulosic material to a separate gelatinizing bath of predetermined concentration and temperature, means to subject one of said webs to the action of heat and pressure to carry its gelatinization sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber, means to superpose a second web upon the first, means to subject the superposed webs to the action of heat and pressure to carry the gelatinization of the second web sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber and to simultaneously cause it to unite with the first web and means for superposing and uniting as many of the remaining webs of gelatinized cellulosic material as necessary to build up to the desired thickness.

8. An apparatus for producing multi-ply webs of indurated fiber comprising the combination of means to subject each of a plurality of webs of cellulosic material to the action of a gelatinizing bath, means to subject each of a group of webs selected from said treated webs to the action of heat and pressure to carry their gelatinization sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber and means to build up a limited web of indurated fiber of predetermined thickness upon each of said selected group of treated webs.

9. An apparatus for producing a predetermined

number of webs of indurated fiber, each having a predetermined number of plies, comprising means for subjecting each of a plurality of webs of cellulosic material to the action of a gelatinizing agent, means to subject each of a group of webs selected from said treated webs to the action of heat and pressure to carry their gelatinization sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber, means to superpose one of the remaining webs upon each of said heat and pressure treated webs and means to apply heat and pressure to each set of superposed webs to form as many webs of dense, homogeneous indurated fiber as there are webs in the group first selected.

10. A method of producing multi-ply webs of indurated fiber comprising the steps of subjecting each of a plurality of webs of paper to the action of a gelatinizing agent, subjecting each of a group of webs selected from said treated webs to the action of heat and pressure to carry their gelatinization sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber and building up a laminated web of indurated fiber of desired thickness upon each of said selected groups of treated webs.

11. A method of producing multi-ply webs of indurated fiber comprising the steps of subjecting each of a plurality of webs of paper to the action of a gelatinizing agent, subjecting each of a group of webs selected from said treated webs to the action of heat and pressure to carry their gelatinization sufficiently far to render said web suitable for incorporation into a multi-ply web of indurated fiber, superposing one of the remaining webs upon each of the selected group of webs and applying heat and pressure to each set of superposed webs to form as many webs of dense, homogeneous indurated fiber as there are webs in the selected group.

12. A continuous method of producing a laminated product of vulcanized fiber which consists in laminating a plurality of continuously moving webs of gelatinized paper while said webs are maintained in substantially flat condition.

13. A method of producing a laminated product of vulcanized fiber which consists in continuously forming a substantially flat web of indurated fiber and then progressively and continuously superposing one or more layers of gelatinized paper upon said flat web and consolidating the assembly by the means of heat and pressure while both said web and superposed layers are maintained in substantially flat condition.

14. An apparatus for producing a web of vulcanized fiber having a predetermined number of plies, said apparatus comprising a series of units equal in number to the number of plies in the finished product and arranged in parallel relation along the length of the web to be produced thereby, each unit consisting of a supply roll, a gelatinizing bath disposed below and to one side of said supply roll and two closely spaced heat and pressure applying cylinders disposed below the said supply roll, whereby a web of paper may be drawn from the supply roll of the first unit, conducted through the corresponding gelatinizing bath, around the upper of the corresponding cylinders and between the corresponding cylinders to be formed into the base web upon which the webs of paper treated in each of the other units may be superposed and consolidated therewith by means of the heat and pressure applying cylinders of the subsequent units.

15. An apparatus for producing a web of vulcanized fiber of a predetermined number of plies comprising a plurality of horizontally spaced supply rolls equal in number to the number of plies in the finished product, a set of heat and pressure applying cylinders disposed below and in close relation to each of said supply rolls, and a gelatinizing bath disposed to one side of each of said set of cylinders, whereby a web of paper drawn from any of said supply rolls may be passed through the corresponding gelatinizing bath, and between the corresponding set of cylinders and between each subsequent set of cylinders.

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