May 15, 1951 D. D. ADAMS ET AL 2,552,612

CONTINUOUS IMPREGNATION OF FORMED FIBROUS MATERIAL

Filed July 18, 1946 3 Sheets-Sheet 1

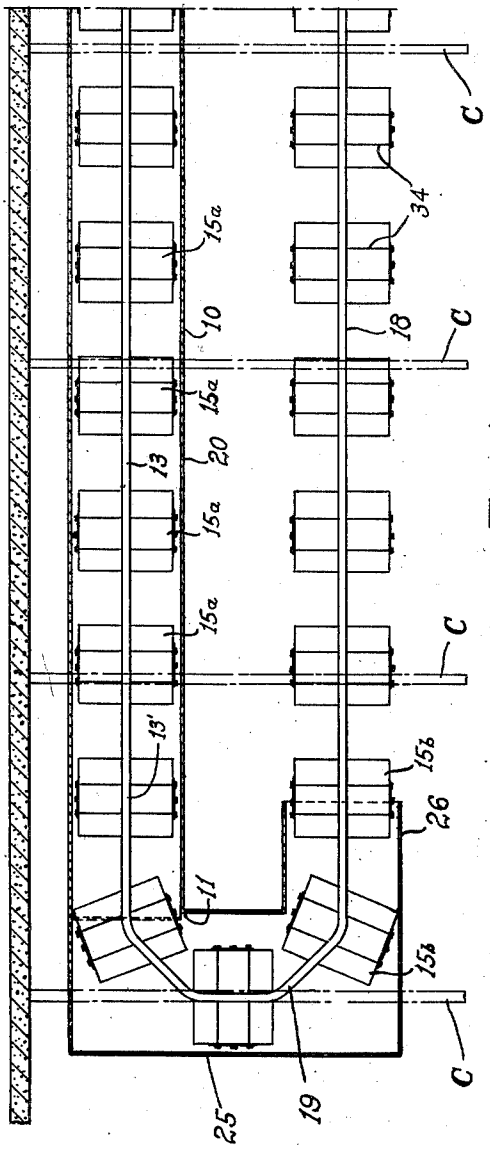


Fig. 1a

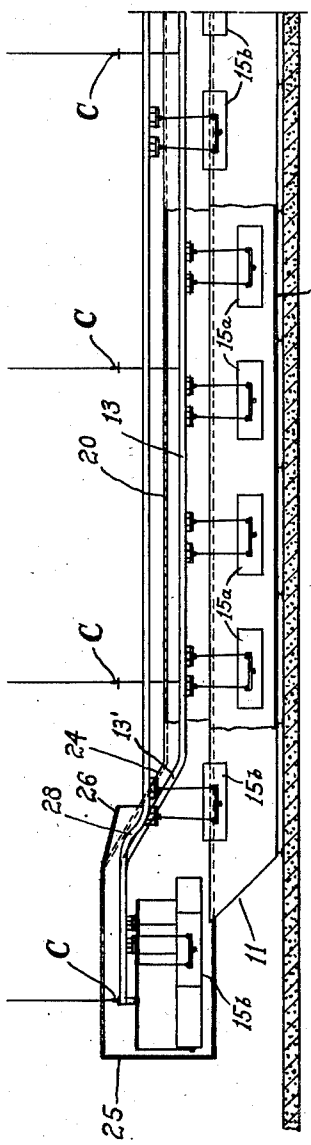


Fig. 2a

INVENTORS
Douglas D. Adams
BY Karl Rollius and
John D. Risher
Treasse and Bialick
ATTORNEYS

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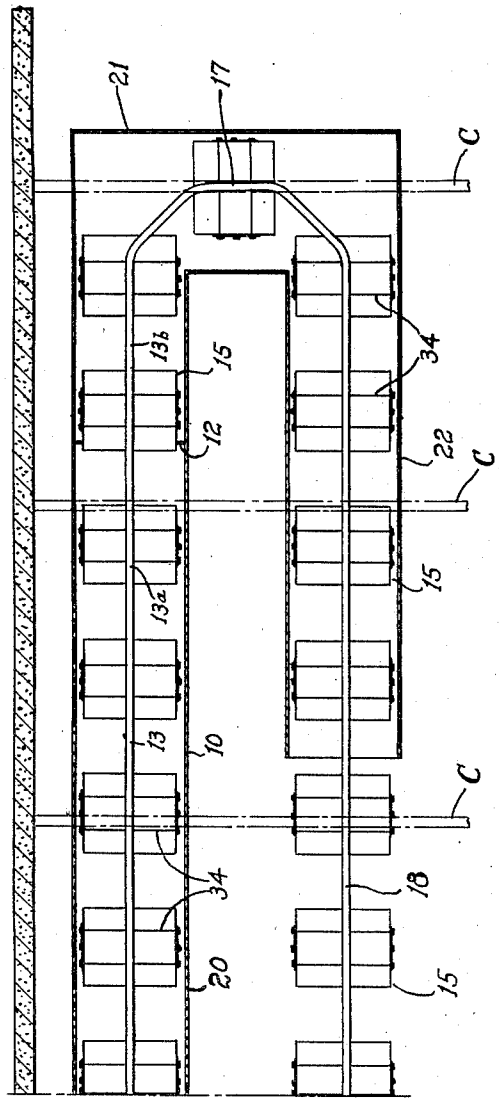


Fig. 1b

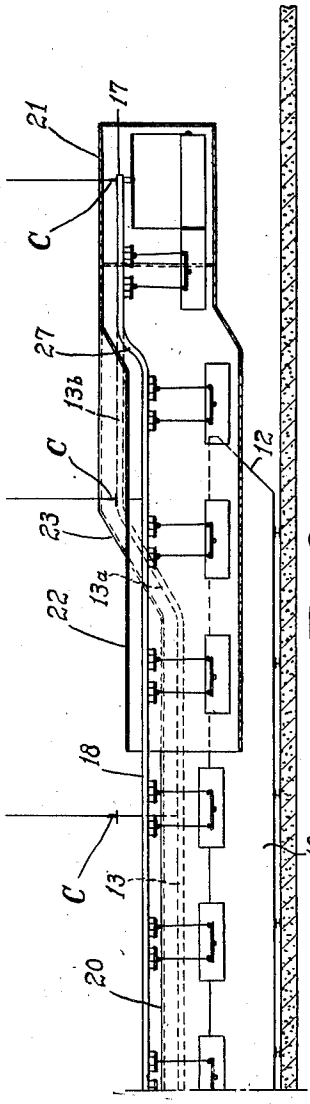


Fig. 2b

INVENTORS
Douglas D. Adams
BY Karl Rollius and
John D. Risher
Treasr and Bisbee
ATTORNEYS

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CONTINUOUS IMPREGNATION OF FORMED FIBROUS MATERIAL

Filed July 18, 1946 3 Sheets-Sheet 3

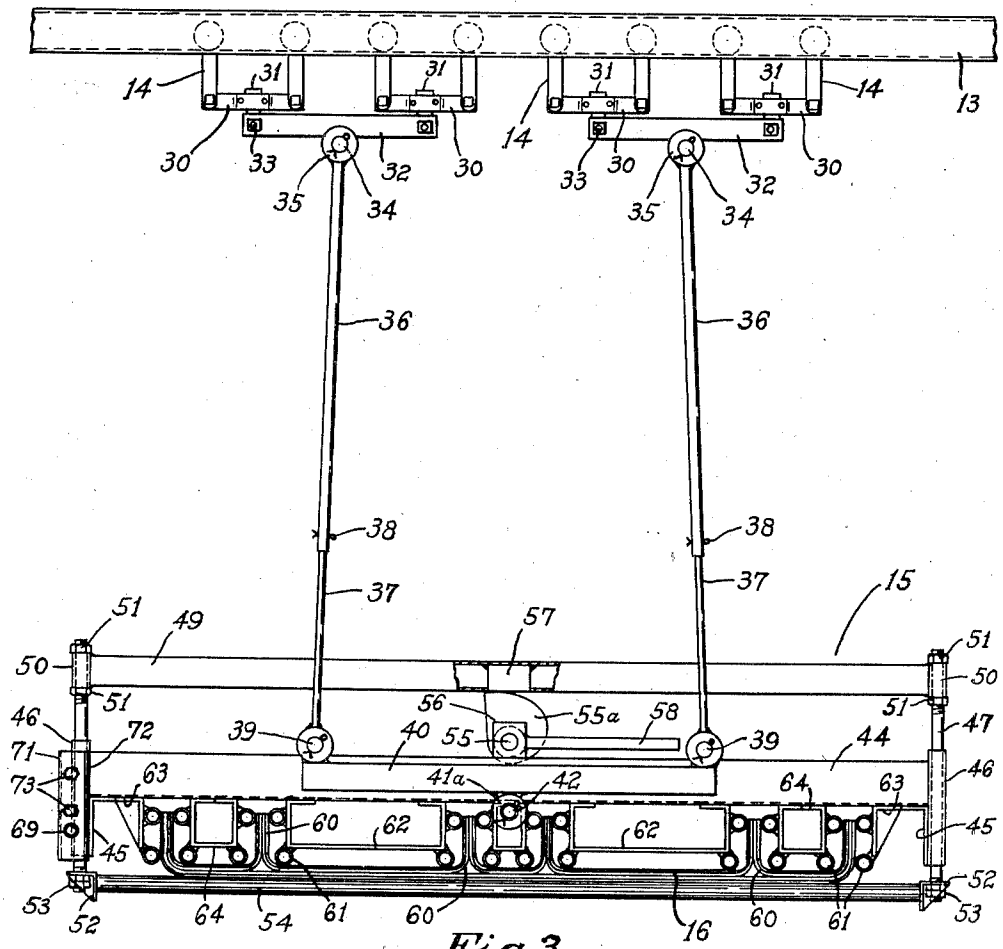


Fig. 3

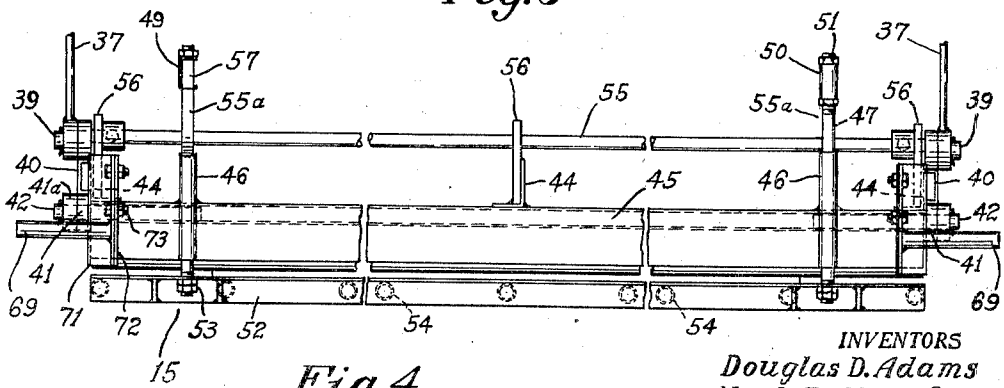


Fig. 4

INVENTORS
Douglas D. Adams
BY Karl Rollius and
John D. Risher
Frease and Bishop
ATTORNEYS

Patented May 15, 1951

2,552,612

UNITED STATES PATENT OFFICE

2,552,612

CONTINUOUS IMPREGNATION OF FORMED FIBROUS MATERIAL

Douglas D. Adams, Karl Rollius, and John D. Risher, Canton, Ohio, assignors, by mesne assignments, of 76.89 per cent to R. E. MacKenzie and 23.11 per cent to L. V. Bockius

Application July 18, 1946, Serial No. 684,462

2 Claims. (Cl. 117—113)

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The invention relates generally to a novel method for continuously impregnating articles of fibrous material with a chemical compound, in order to strengthen and stiffen the articles.

More particularly, the invention relates to a novel method for continuously impregnating articles of preferably laminated corrugated paper board, formed in a particular contour, so as to provide an impregnated article having maximum strength and minimum weight while maintaining its preformed shape.

In impregnating articles of laminated corrugated paper board with a stiffening and strengthening compound, the articles are dipped into a suitable chemical compound, preferably a molten bath of sulfur compound, which on solidification imparts added strength and rigidity. We have discovered that in dipping such articles of preformed shape, the articles must be securely bound or held in shape throughout the immersion period, because otherwise the molten bath will cause the article to lose its shape entirely.

We have discovered also that such preformed articles should be dipped in a position which will insure the flow of the molten compound into and through all of the corrugations, because otherwise the impregnation is not uniform throughout the article, and blisters are very apt to form between the plies or laminations in the areas where the compound has not penetrated.

We have discovered further that such preformed laminated articles should be withdrawn gradually from the molten bath in such position as to uniformly and completely drain excess compound from the articles, because otherwise the excess compound when solidified adds unnecessary weight to the articles, and the excess solidified compound will dust off when the article is used.

We have discovered still further that such laminated articles should be preheated before dipping to drive out moisture in the paper plies, should be immersed under time and temperature conditions which are carefully controlled in relation to the character and dimension of the article, and should be gradually cooled after withdrawing from the bath to insure proper drainage and uniform solidification of the compound.

The present invention resides in carrying out all of these requirements as part of an efficient and inexpensive continuous procedure, by which preformed laminated fibrous articles are impregnated rapidly to impart maximum strength and rigidity while maintaining their preformed contours and dimensions.

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Accordingly, it is an object of the present invention to provide a novel method for continuously impregnating formed laminated fibrous articles to impart strength and rigidity thereto.

Another object is to provide a novel method of continuously impregnating formed laminated fibrous articles in such manner as to maintain their predetermined shape and dimension.

A further object is to provide a novel method of continuously uniformly impregnating formed laminated fibrous articles and completely draining excess impregnating compound therefrom.

Another object is to provide a novel method of continuously impregnating formed laminated fibrous articles including controlled preheating, dipping and cooling operations.

Finally, it is an object of the present invention to provide an efficient method which will accomplish all of the foregoing objectives so as to produce impregnated laminated fibrous articles of predetermined form and shape on a continuous low-cost basis.

These and other objects are accomplished by the methods which comprise the present invention, the nature of which is set forth in the following general statements, and a preferred embodiment of which is set forth in the following description and illustrated in the accompanying drawings, and which is particularly and distinctly pointed out and set forth in the appended claims forming part hereof.

In general terms, the novel method comprising the present invention includes binding the preformed laminated fibrous articles in shape-holding frames and moving said frames continuously through preheating, impregnating, and cooling zones while controlling the time and temperature in said zones, said articles being passed through the impregnating bath in one position and being inverted as they are gradually withdrawn from the bath.

Referring to the drawings in which a preferred embodiment of apparatus for carrying out the invention is shown by way of example,

Figures 1*a* and 1*b* taken together comprise a diagrammatic plan view of the apparatus with parts in section;

Figures 2*a* and 2*b* taken together comprise a diagrammatic side elevation thereof, parts being broken away and in section;

Fig. 3 is an enlarged side elevation showing one of the dipping frames for holding one of the preformed articles carried on the endless con-

veyor which passes over the impregnating tank; and

Fig. 4 is a fragmentary end elevational view taken at right angles to the view of Fig. 3.

Similar numerals refer to similar parts throughout the several views of the drawings.

The laminated preformed corrugated paper articles which are to be impregnated according to the novel continuous method comprising the present invention, are preformed in such contours and dimensions as to provide structural load-bearing units when impregnated. For example, such articles having a channel or multiple channel cross section have been found to be very satisfactory as material carrying platforms used with power lift trucks, and such articles having a channel or angular cross section have been found to be very satisfactory and desirable when used as structural panels or units incorporated in the walls, floors, ceilings, etc., of buildings.

Other uses of such articles will be apparent, and we do not wish to limit this invention to any particular shape or configuration of the articles which are impregnated according to the present invention, except that all of the articles necessarily have one or more angular flanges or legs. The articles shown by way of examples in the drawings as being impregnated are material carrying platforms or pallets, and as best shown in Fig. 3, they are of a composite channel cross sectional shape having a platform or deck with the corrugations running transversely thereof and six flanges or legs extending at right angles therefrom, with the legs bent across the corrugations so that the open ends of the corrugations are at the outer ends of the legs.

As best shown in Figs. 1*a* and 1*b* and Figs. 2*a* and 2*b*, the apparatus includes an elongated tank 10 for containing molten impregnating compound, and having a preferably sloping entrance end 11 and a preferably sloping exit end 12. The tank is filled to a desired level with molten sulfur compound, and the compound may be maintained at a temperature of preferably 130° C. to 140° C. by means of steam coils (not shown) arranged in the bottom of the tank in a usual manner. The sulfur compound which we prefer to use is 90 to 95% of sulfur, and 5 to 10% of an introfier such as Thiokol or Aroclor or Halowax, or a combination of two or more of said introfiers. Thiokol is a combination of organic polysulfides, Aroclor is a chlorinated diphenyl, and Halowax is a chlorinated naphthalene. However, the impregnating compound may be varied considerably and the particular composition of the compound per se forms no part of the present invention.

The conveying means for moving the particular articles shown to be impregnated through the molten compound in tank 10 preferably includes a roller conveyor chain passing longitudinally over the center of the tank 10, being rollably supported in a tubular track 13 having a longitudinal slot in its bottom wall through which links 14 depend for attachment to the carriers which support the dipping frames containing the preformed articles to be impregnated. The conveyor chain and track are of usual and well known construction, and are therefore not shown in detail in the drawing, and the depending links 14 carried by the chain are best shown in Fig. 3.

The dipping frames indicated generally at 15 are each adapted to bind and hold in shape one of the articles 16 to be impregnated, and the

frames are supported by the links 14 at intervals along the conveyor chain rolling in track 13. As shown in Figs. 1*a* and 1*b*, after the track 13 passes over the tank 10, it turns to the right 45°, then 90° and then 135° to provide a reverse bend 17 of the track which is connected to a return run 18. The return run 18 of the track is connected at its forward end to another reverse bend 19 similar to the bend 17, and which joins the forward run 13 of the track and forms a closed loop.

As indicated diagrammatically in Figs. 1*a* and 1*b* and Figs. 2*a* and 2*b*, the track may be suitably supported on the bottom chords C of roof trusses located above the track.

As shown in Figs. 1*a*, 1*b*, 2*a* and 2*b*, a hood 20 is provided over the impregnating tank 10, and the hood is connected at the exit end 12 of the tank to a rectangular duct 21 which substantially follows the track around the reverse bend 19 and back along the return run of the track a considerable distance as indicated at 22, so that the track and dipping frames carried thereby are enclosed by the duct for a substantial period of time after passing beyond the impregnating tank 10. The combined length of the portions 21 and 22 of the duct is such as to enclose the dipping frames for several minutes after they are withdrawn from the impregnating bath, and as shown in Fig. 2*b*, the hood 20 is inclined upwardly at 23 to connect to the duct 20 so that the heated atmosphere under the hood communicates with the duct and envelopes the articles leaving the impregnating tank so that they cool very gradually.

As indicated in Figs. 1*a* and 2*a*, the hood 20 slopes upwardly at the entrance end of the tank to form a portion 24 which merges into and communicates with an L-shaped entrance duct 25 enclosing the reverse bend 19 of the track and the dipping frames carried thereby, the entrance duct 25 having a portion 26 enclosing the forward end of the return run 18 of the track and the frames carried thereby. The entrance duct 25 is filled with the heated atmosphere within the hood, so as to provide a preheating zone for the articles entering the duct on their way to the impregnating tank 10. As indicated in Figs. 2*a* and 2*b* the track 13 is inclined parallel with the portions 24 and 23 of the hood so as to pass the articles carried in the frames through the impregnating bath, and the return run 18 of the track is slightly lowered by the downwardly inclined portions 27 and 28 so as to bring the dipping frames on the return run 18 of the track to a convenient loading and unloading elevation between the discharge duct 22 and the entrance duct 26.

Referring to Fig. 3, the dipping frames 15 are supported on the conveyor chain at suitable intervals along the same, and the supporting means preferably includes yokes 30 suitably connected to the lower ends of adjacent pairs of the links 14. Studs 31 are journaled in and extend vertically through the yokes 30, and longitudinal supporting links 32 are pivotally connected at their ends to the depending ends of adjacent studs 31, as by bolts 33. A cross rod 34 is secured as by welding to the center of each link at its lower edge, and projects laterally therefrom in each direction so that its outer ends are substantially over the laterally outer edges of the dipping frame 15 carried thereby.

The outer ends of the rods 34 have collars 35 swiveled thereon, and the collars are secured as by welding to the upper ends of hanger tubes 36,

The hanger tubes 36 telescope over the upper portions of the hanger rods 37, and are secured thereto preferably by pins 38 passing through holes in the rods 37. A series of such holes may be provided in the rods for adjusting the length of the hanger rods and thus adjusting the height at which the dipping frame 15 is carried.

The bottom ends of each pair of hanger rods 37 are detachably swiveled at 39 to the outer ends of longitudinally extending carrier bars 40 which may be channels as shown and which are located at opposite sides of the frame 15. In the center of each bar 40 at its bottom edge a swivel ring 41 is secured as by welding and said swivel rings are journaled on the ends of rods 42 extending transversely of and rigidly secured to longitudinal angles 44 of the dipping frame 15. The rings 41 are detachably held on rods 42 by collars 41a. Accordingly, each dipping frame 15 is rotatable end for end on the pivots 42.

Each dipping frame 15 preferably includes an intermediate portion which is fixed on the pivot rods 42, and an outer portion which is vertically movable relative thereto. The fixed portion preferably includes longitudinally extending angles 44, one at each side of the frame and one extending through the center thereof. The longitudinal angles 44 are supported at their outer ends on transversely extending angles 45 which extend throughout the full width of the frame proper. A pair of vertical guide tube 46 is secured as by welding to the outer surface of each angle 45, said tubes being preferably spaced laterally inward a slight distance of the outside angles 44 of the frame.

The movable part of the frame is movably and detachably mounted in these tubes 46 by means of vertical rods 47 which extend slidably through the tubes. Preferably, the rods 47 are provided with screw threads at their top and bottom ends, and longitudinal channel braces 49 connect the top ends of opposite rods 47. preferably the ends of the channels 49 have tubular bosses 50 welded at their ends, and these bosses are adjustably secured to the top ends of the rods 47 by means of lock nuts 51. To the bottom ends of the rods 47 transverse angles 52 are connected by means of nuts 53, and a plurality of longitudinal pipes or tubes 54 have their ends welded to the inner legs of the angles 52, said pipes being spaced at intervals transversely of the frame.

Means for moving the outer part of the frame vertically relative to the fixed intermediate part for binding the channel 16 to maintain its shape, preferably includes a cam rod 55 located midway of the transverse angles 45 and extending parallel thereto. The cam rod 55 is journaled in a plate 56 secured to the middle longitudinal angle 44, and is journaled at its ends in similar plates 56 secured as by welding in the outside angles 44. As shown in Figs. 3 and 5, the cam rod 55 is located between the angles 44 of the fixed portion of the frame and the upper channels 49 of the movable portion. Directly beneath each channel 49 a cam 55a is secured on the rod 55, and the outer surface of the cam 55a is adapted to engage a cam block 57 welded in the channel 49. Operating handles 58 are attached to the cam rod 55, preferably one just inside of each of the plates 56 in which the ends of the cam rod 55 are journaled.

The article 16 which is shown in this case is a multiple channel material carrying platform, which is placed on the pipes 54 with the legs 60 of the channels running transversely of the frame, and with the deck or platform resting on the pipes 54 and the legs 60 extending upwardly therefrom. The material carrying platform is thus placed or loaded into the frame in inverted position, for a purpose to be hereinafter described.

The means for engaging the article 16 to maintain its contour and shape during the impregnating operation is preferably a form or a series of forms secured to the undersides of the channels 44. As shown in the drawings, the form may consist of a series of pipes or tubes 61 extending transversely of the frame parallel to the legs 60 of the article, and supported by means of straps or the like 62, 63 and 64, which are secured as by welding to the undersides of each of the angles 44, and to which the pipes 61 are welded. As shown the pipes 61 are arranged to include a pair of upper and lower pipes on each side of each of the legs 60 of the article.

Referring to Fig. 3, the cam handle 58 is shown turned through 180° for raising the outer movable part of the frame and engaging the several legs 60 of the article 16 between the respective pairs of pipes 61. As the cams 55a are rotated to the position shown in Fig. 3, their engagement with the blocks 57 forces the outer movable part of the frame upwardly and raises the supporting pipes 54 to raise the legs 60 of the article upwardly between the pipes 61. In the closed position of Fig. 3, the upper pipes engage and bind the upper or outer ends of the legs, and the lower pipes engage and bind the underside of the deck at points adjacent to the legs. In this position the frame is adapted for maintaining the shape and contour of the article 16 during the impregnating operation, without covering any substantial part of the surface of the article, because the pipes provide for line contacts with the article at spaced points.

By rotating the cam handle 58 through 180° to released position, the weight of the outer part of the frame is allowed to move it downwardly to lower the supporting rods 54 and separate the channel legs 60 from the upper tubes 61 so that the article 16 can be unloaded and replaced.

The operation of gradually inverting the dipping frames as they are withdrawn from the impregnating tank, so as to drain excess impregnating compound from the articles 16, may be accomplished by providing suitable means at the discharge end 12 of the tank for gradually inverting the dipping frames to turn the legs of the articles 16 downwardly as they leave the impregnating bath. Such means may include suitable cam tracks or guides on opposite sides of the tank slidably engaging the studs 69 projecting from opposite sides of the frame.

Preferably the studs are adjustably mounted vertically by securing their inner ends to vertical angles 71 which are in turn vertically slidable on angles 72 welded to the front ends of the outer angles 45 of the fixed portion of the frame. The angles 71 are adjustable on the angles 72 by means of bolts 73 passing through holes in the angles 71 and through slots in the angles 72.

As the inverted dipping frames pass over the exit end 12 of the impregnating tank, they pass immediately into the duct 21 which communicates with the hood 20, so that the heated atmosphere enclosed above the impregnating liquid within the hood 20 continues to circulate around the dipping frames so as to provide for gradual cooling of the articles held therein.

In the operation of the novel method of the present invention, assuming that the dipping

frames indicated at 15b in Figs. 1a and 2a are loaded with laminated corrugated paper articles 16 to be impregnated, the dipping frames first are moved by the conveyor into the entrance end 26 of the duct, and are carried by the bend 19 of the conveyor track through the portion 25 of the entrance duct. The entrance duct is filled with the heated atmosphere circulating from within the hood 20 communicating with the entrance duct, so that the articles 16 carried by the dipping frames 15b are preheated to drive out entrained moisture before reaching the impregnating tank 10. The dipping frames 15b are of course in their normal position shown in Fig. 3, so that the articles 16 held in the frames are in inverted position, that is, the legs or flanges 60 extend upwardly.

As the dipping frames pass over the downwardly inclined portion 13' of the conveyor track they are lowered gradually into the molten impregnating compound contained in tank 10 to the immersion position shown by the dipping frames 15a, and are maintained at this level substantially throughout their travel longitudinally through the impregnating tank. As the articles 16 held by the dipping frames are immersed into the molten impregnating compound, the inverted position of the articles permits the molten compound to flow rapidly into the tubular passages formed by the corrugations, because the open ends of the corrugations are at the upper ends of legs 60. Any trapped air in the corrugations is driven off with entrained moisture in the form of steam which bubbles through the molten impregnating compound. If the articles 16 are immersed with the legs 60 depending downwardly, the trapped air and steam is apt to form bubbles within the corrugations and cause a separation of the plies or laminations at various points in the platform or deck of the article. By immersing the channels 16 in inverted position, the danger of forming bubbles resulting in separation of the plies is substantially eliminated and the molten compound flows into and through all of the corrugations so as to uniformly impregnate the article.

As soon as the articles 16 are immersed in the molten impregnating compound, the corrugated paper laminations lose practically all of their rigidity and would consequently lose their preformed shape entirely if it were not for the fact that they are held accurately in shape by the pipes 54 and 61 of the dipping frames.

By engaging both sides of the ends of the legs 60 between pairs of the pipes 61 and by engaging the platform or deck of the article at points adjacent to the legs while supporting the deck at intervals on the pipes 54, the preformed shape of the article is accurately maintained, while at the same time the engagements between the article and the pipes are substantially line contacts so as to allow the impregnating compound to come in contact with substantially all of the surface of the article. By changing slightly the positions of the forming tubes or pipes 61, the contours of the article 16 can be altered somewhat in shape during the impregnating operation. Thus, if the angularity of the legs 60 is desired to be changed to produce a back-drafted article, this can be done in the impregnating operation by slightly changing the positions of the forming pipes 61, whereas it is impossible to form such a back-drafted article when preforming the laminations to produce the articles 16 before they are impregnated.

As previously stated, the temperature of the molten impregnating compound is maintained at about 130° C. to 140° C. by suitable means such as steam coils at the bottom of the tank. The speed of travel of the frames is correlated to the length of the tank so that the articles carried by the frames are immersed for a period of approximately 10 to 15 minutes, which we have found the period required to produce complete and uniform impregnation of these particular articles 16. However, for laminated articles of different materials, contours and dimensions, the immersing time and the temperature of the bath may be varied as required.

As the dipping frames pass through the exit end of the impregnating tank 10, they are gradually tilted to an inverted position in the manner previously described, and because of being inverted as they are raised out of the impregnating liquid, all excess impregnating compound is thoroughly drained from within the channels and from within the corrugations of the channels. Due to the fact that the frames on leaving the tank pass immediately into the duct 21 which communicates with the hood 20, the temperature of the atmosphere in the duct is only 6° to 8° lower than the temperature of the bath, so that the solidification of the impregnating compound left in the pores of the article takes place very gradually, which provides sufficient time for the molten compound to drain completely from the corrugations. The combined length of the duct 21 and the return duct 22 is correlated with the speed of travel of the frames so that the dipping frames are within the duct for about 5 to 7 minutes after leaving the impregnating tank.

As the dipping frames move continuously along the closed loop of the conveyor track, the space on the return run 18 of the track between the discharge end of the return duct 22 and the entrance end 26 of the entrance duct 25 is available for the operations of manually turning the frames back to the upright position shown in Fig. 3, then releasing the movable portions by turning the handles 58 to rotate the cams 55a and lower the bottom pipes 54 of the frames together with the articles 16, and then removing the impregnated articles and replacing and clamping new preformed articles in the frames to be impregnated.

Accordingly, the present invention provides for carrying out a novel continuous method of impregnating preformed laminated fibrous articles for strengthening the same, while maintaining their preformed contours and dimensions.

In the foregoing description, certain terms have been used for brevity, clearness and understanding, but no unnecessary limitations are to be implied therefrom beyond the requirements of the prior art, because such words are used for descriptive purposes herein and are intended to be broadly construed.

Having now described the invention, the construction, the operation and use of a preferred embodiment thereof, and the advantageous new and useful results obtained thereby; the new and useful methods, and reasonable mechanical equivalents thereof obvious to those skilled in the art, are set forth in the appended claims.

We claim:

1. The method of continuously impregnating laminated corrugated paper channels having transversely extending corrugations forming

tubular passages opening at the ends of the channel legs, comprising the steps of holding said channels to maintain their shape, continuously moving said channels in legs-up position into and through a heated impregnating bath, and inverting said held channels as they pass out of said bath.

2. The method of continuously impregnating preformed laminated corrugated paper articles having at least one angular leg and having transversely extending corrugations forming tubular passages opening at the end of the leg, which includes engaging both sides of the leg at its outer end to hold the articles to maintain them in predetermined shape, moving said articles with said leg extending upwardly continuously through a heated impregnating bath, and inverting and draining the articles as they move continuously out of said bath.

DOUGLAS D. ADAMS.
KARL ROLLIUS.
JOHN D. RISHER.

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