Oct. 29, 1957 D. B. MONTGOMERY 2,811,200

METHOD OF DRYING VISCOUS FLUIDS WHICH FORM FILMS OF VARYING THICKNESS ON REVOLVING, HEATED DRUMS

Filed Oct. 14, 1952 2 Sheets-Sheet 1

Fig. 1.

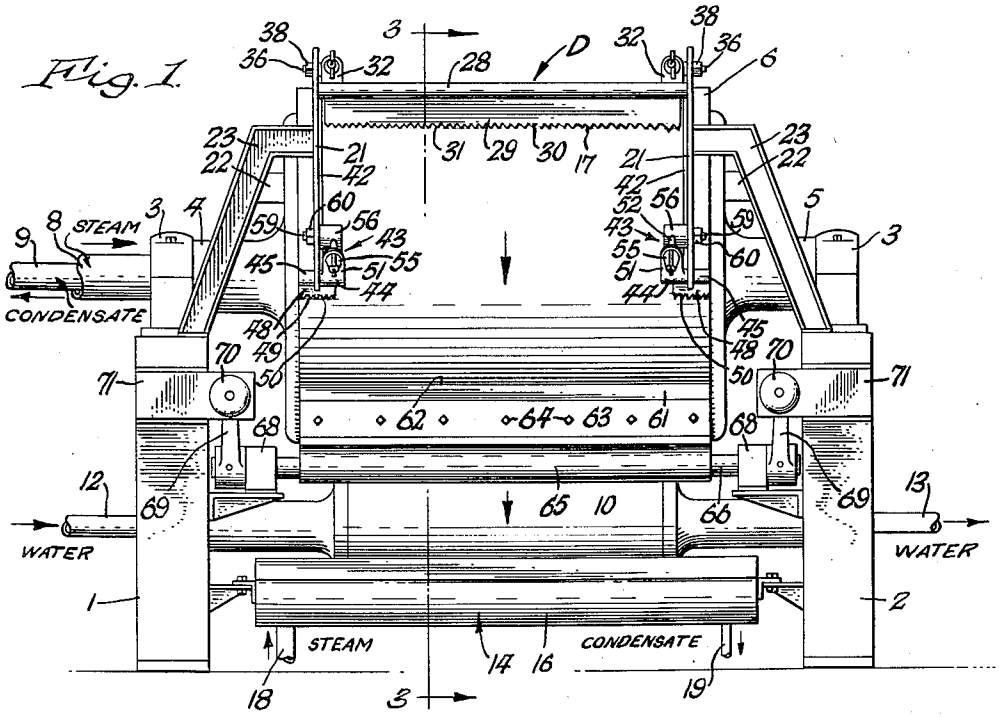


Fig. 2.

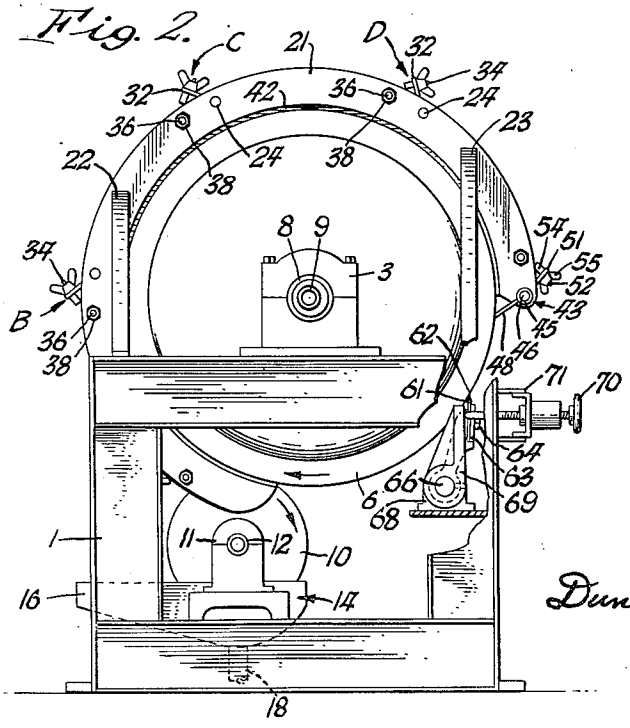
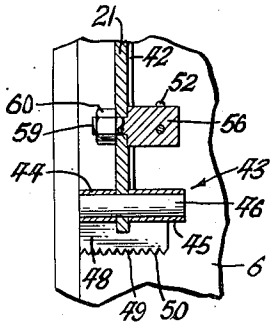


Fig. 8.



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Fig. 3.

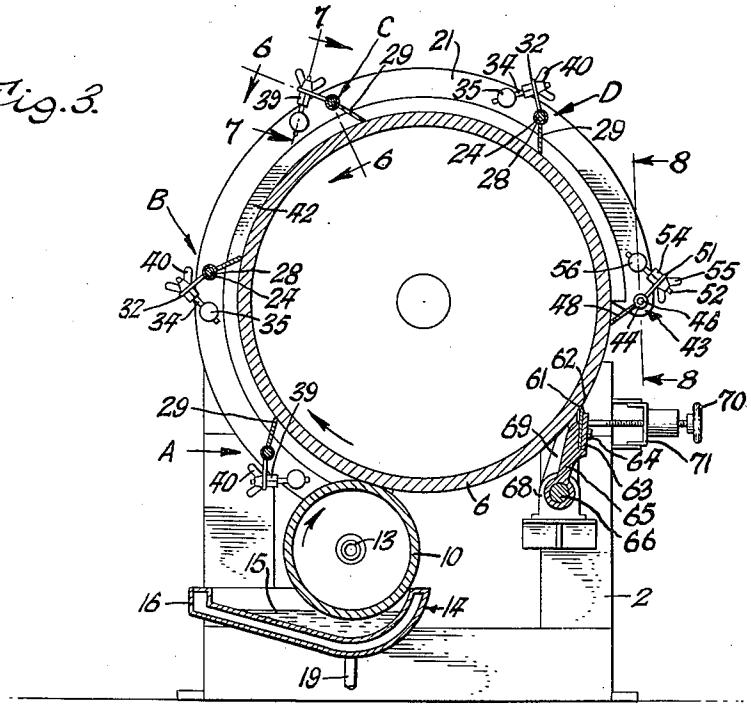


Fig. 4.

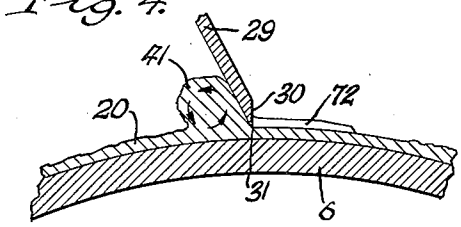
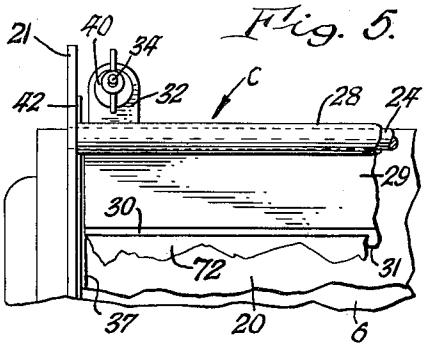


Fig. 5.



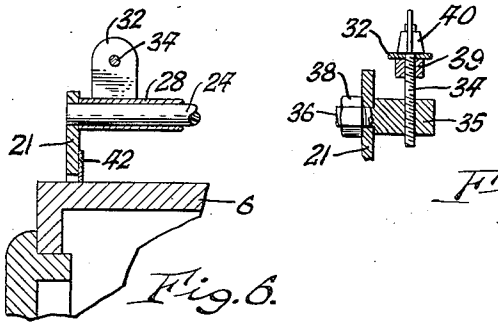


Fig. 6.

Fig. 7.

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METHOD OF DRYING VISCOUS FLUIDS WHICH FORM FILMS OF VARYING THICKNESS ON REVOLVING, HEATED DRUMS

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Application October 14, 1952, Serial No. 314,666

13 Claims. (Cl. 159—49)

This invention relates to a method for drying glue and like liquids containing solids which do not readily form a smooth coating of uniform thickness on a revolving, heated, cylindrical drying surface. While the invention is applicable to vegetable and animal glues, it is especially applicable to high grade hide and bone glue in the drying of which special difficulties are encountered.

While the drying of some vegetable glues and low grade animal glues on revolving heated cylindrical drums have presented no special problems to the industry, constant effort has been made over the years to provide a method of producing high density high grade hide glue by the same method. At present most of the dried high grade glue is prepared by concentrating the glue solution, chilling to make a gel and drying the gel slowly in a hot air belt dryer. To do this in summer when atmospheric humidity is high without liquefying the gel requires the use of conditioned air. The process is costly and critical and a great deal of expensive equipment requiring a large amount of floor space is required. Attempts have been made to overcome the disadvantages of this present commercial process generally used such as the use of a film wheel with warm air passing over the surface of the wheel; manufacturing pearl glue by dropping liquid glue into boiling toluene; and the use of a very large drying roll for partial drying of the glue, chilling the partially dried glue, and using a belt dryer for final drying of the glue.

All of these processes, however, present disadvantages over drying the bone and hide glue by applying it as a layer to a heated drying drum and removing the dried glue with a doctor blade. However, attempts heretofore to produce bone and hide glue in this manner resulted in a fluffy, spongy or flocculent product of reduced strength. An essential condition is that the glue be produced in a form which can be reduced to dense granules since otherwise, on redissolving the glue for use, the glue will ball up and the balls resist penetration of water to their centers so that dissolving glue from fluffy or flocculent granules or masses is unsatisfactory. A dense product also takes up less space and reduces shipping charges.

Accordingly, such prior attempts to drum dry bone and hide glue, especially high grade hide glue which has a high gel strength, have not been successful. The results of the present invention indicate that such failure to drum dry bone and hide glue was due primarily to the well known fact that when a hot glue solution is exposed to the air it quickly forms a skin over its surface. Spread in a thin layer on a heated surface, such as a drying drum, this skin forms much more rapidly. This skin forms a barrier which greatly retards the escape of moisture. If the steam pressure in the drying drum is raised high enough to cause steam bubbles in the glue which rupture the skin, the product at the doctor blade is spongy, fluffy or flocculent and hence highly unsatisfactory in redissolving for use as previously noted.

It is the principal object of the present invention to dry liquid containing solids which do not readily form a smooth coating of uniform thickness on a revolving,

heated, cylindrical drying surface, such as vegetable and animal glues and particularly high grade, high gel strength hide glues, by applying a concentrated solution to a heated revolving drying drum and removing the dry film from the drum in a condition which, while it may be soft and even tacky at the doctor blade, rapidly forms into a dense hard form which can readily be reduced to any desired particle size and when so reduced readily enters into solution.

Another object is to provide such a process in which the product is of high quality, particularly in point of being of high density, of high gel strength and readily soluble. It is particularly important that the process result both in a minimum loss of gel strength and also in a dense product that can readily be dissolved.

Another object is to provide such a method which is rapid and continuous in operation and of more economical capacity as compared with present processes.

Another object is to provide such a method in which the necessity for close control and supervision is reduced.

Another object is to provide such a process which permit accurate control of the conditions under which the glue is dried.

Another object is to provide a process capable of being practiced with apparatus which is simple and inexpensive in construction and is not complicated to operate nor presents other service difficulties.

Another object is to provide such a process in which the dried glue can be produced at low cost.

Another object is to provide such a process in which the need for chilling the glue is eliminated and to provide apparatus which requires little floor space.

While the invention is primarily concerned with drying the difficult high grade hide and bone glue, there are a great many vegetable glues on the market which vary greatly in consistency, viscosity and gel strength. The dryer of the present invention can advantageously be used with such vegetable glues in that the dryer permits the drying of a heavier layer at a higher concentration by virtue of a part of the drum surface being used to concentrate the liquid to a state where it no longer flows readily or can be handled by a pump.

Other objects and advantages of the invention will be apparent from the following description and drawings in which:

Fig. 1 is a side elevational view of a drum dryer suitable for practicing the present invention.

Fig. 2 is an end elevational view of the drum dryer shown in Fig. 1.

Fig. 3 is a vertical transverse section taken on line 3—3, Fig. 1.

Fig. 4 is a fragmentary enlarged view similar to Fig. 3 and showing in particular the action of certain of the several full length spreader bars upon the layer of glue on the drum surface.

Fig. 5 is a fragmentary face view of one of these full length spreader bars, this view being on a scale intermediate that of Fig. 4 as compared with Figs. 1–3.

Figs. 6 and 7 are enlarged fragmentary views taken on correspondingly numbered lines of Fig. 3.

Fig. 8 is an enlarged fragmentary section taken on line 8—8, Fig. 3 and in particular illustrating one of the shorter spreader bars.

The practice of the present invention is preferably carried out with an atmospheric drum dryer as shown in the accompanying drawings in which the numerals 1 and 2 represent the trunnion stands of the dryer and each of which carries a bearing 3 in which tubular end shafts 4 and 5 of the drying drum 6 are journalled to rotate about a horizontal axis. The drying drum 6 is heated by the introduction of steam into the interior of the drum and the removal of condensate therefrom in a manner well known

in the art, a steam inlet pipe being conventionally indicated at 8 and condensate outlet pipe at 9 for this purpose. The pressure of the steam is maintained within the limits hereinafter set forth to provide the range of operating temperatures which have been found essential to the practice of the invention.

The glue is applied to the surface of the drum 6 by an applicator roll 10 which is arranged under the drum 6, parallel with its axis and with its periphery in closely spaced relation to the periphery of the rising side of the drum. This applicator roll 10 is journalled at its ends in bearings 11 carried by the trunnion stands 1 and 2. The applicator roll 10 is maintained at a desired temperature, as hereinafter more fully set forth, by cooling water and for this purpose is conventionally shown as connected with a water inlet pipe 12 at one end and with a water outlet pipe 13 at its opposite end. The drum 6 and the applicator roll 10 are preferably driven in the direction of the arrows associated with these parts in the various figures of the drawings so that their surfaces, at their points of closest approach, move in opposite directions relative to each other. This can be effected by any suitable form of drive (not shown) and, as viewed in Fig. 2, both the drum 6 and the applicator roll 10 rotate in a clockwise direction.

The bottom of the applicator roll 10 dips into a pan 14 containing a body 15 of liquid glue, this glue being maintained at the desired temperature by the application of heat or a coolant, if necessary, to the pan. For this purpose this pan 14 is shown as being jacketed, as indicated at 16, and the jacket space supplied with steam or hot or cold water from a pipe 18, the condensate or water being removed by a pipe 19. A thick layer of this glue from the body 15 is picked up by the applicator roll 10 and is partly transferred to the periphery of the drying drum 6 near the crest of this applicator roll. The essential function of the applicator roll 10 is to prevent prolonged or overheating of the glue. The applicator roll applies a layer of the glue of the desired thickness to the drying drum 6, the thickness of this layer applied to the drying drum being determined by the speed of the applicator roll, by its spacial adjustment in relation to the drying drum and by the concentration temperature and viscosity of the glue. Any glue in excess of the amount required to provide a layer of glue on the drying drum of the desired thickness is held back in a body where the applicator roll and drying drum approach each other and from which part of the glue flows back over the surface of the applicator roll back into the pan 14. As hereinafter described, the layer of glue applied by the applicator roll 10 to the drum 6 is in excess of that handled by the drum this excess being removed from the drum and returned to the pan 14 by the first one or two of a series of spreader bars.

The principal feature of the present invention resides in a series of full length spreader bars, indicated at A, B, C and D, and which act in succession upon the layer of glue 20 being carried around on the periphery of the drying drum 6. To support these spreader bars at spaced intervals around the drum 6, a semicircular supporting plate 21 is shown as extending around each end of the drum from about a 6:30 o'clock to a 3:00 o'clock position as viewed in Fig. 2. The inner edge of each of these semicircular plates 21 is maintained in closely spaced relation to the periphery of the drum by supporting arms 22 and 23 which are welded or otherwise secured to the outer sides of these semicircular supporting plates and project outwardly and downwardly with their lower ends suitably secured to the corresponding trunnion stands 1 and 2.

The full length spreader bars A, B and C are identical in construction and the same reference numerals have therefore been applied to the parts of these various spreader bars and the same description applying. The spreader bar D can also be of the same construction as the spreader bars A, B, C and hence the same description also applies. However, for some applications it is desirable to have the edge 17 of the spreader bar D serrated. The serrated form of the edge of this spreader bar tends to form ridges in the layer of glue on the drum and thereby not only expose more surface of the layer and thereby facilitate the escape of moisture but also to provide a dried sheet the ridges of which are thicker and denser than would be the case if such ridges were not provided. The division of the layer into ridges also facilitates breaking up the layer when dried, the grooves between the ridges providing weakened lines in the layer. While the material in the thin section, on leaving the drum, will be slightly lower in moisture than the heavier or ridge section, this condition will be equalized in storage.

In the practice of the invention, as viewed in Fig. 3, the spreader bar A is shown to be located at about the 7:30 o'clock position; the spreader bar B at about the 9:30 o'clock position; the spreader bar C at about the 11:30 o'clock position, and the spreader bar D at about the 1:00 o'clock position. The actual number and location of these spreader bars is determined by the grade and character of the glue being dried and by the diameter and speed of the drum.

Each of these full length spreader bars is mounted on a rod 24 which is secured at its opposite ends in the pair of semicircular supporting plates 21 as best shown in Figs. 5 and 6. On each of these rods 24 between the semicircular supporting plates 21 is mounted the tubular hub 28 from which an elongated blade 29 projects radially. Each blade 29 projects toward the surface of the drum 6 and is preferably disposed at an acute angle relative to the drum radius intersecting the edge 31 of the blade so as to incline backwardly or downstream as shown. The working edge of each blade 29 can be of any suitable form but is shown as being beveled as indicated at 30 to provide a relatively sharp edge 31 projecting toward the drum with the bevel 30 radially disposed with reference to the drum.

An important feature of the invention resides in the exact spacing of the sharp edge 31 of each blade 29 with reference to the drum surface. To individually adjust this spacing of each of these blades 29, each end of the hub 28 of each spreader bar is provided with an apertured ear 32 which projects from this hub in the opposite direction from its blade 29. As best shown in Fig. 7 the threaded shank of an adjusting swing bolt 34 extends through each of these apertured ears 32 and the opposite end of each of these shanks is anchored in the enlarged head 35 of a bolt 36, the shank of which extends through the corresponding semicircular supporting plate 21 and is held in place by a nut 38. Each swing bolt 34 carries a backing nut 39 and a wing nut 40, these nuts being arranged on opposite sides of the corresponding apertured ear 32. It will be seen that the pair of nuts 39 and 40 on the swing bolts 34, permits an adjustment which determines the position of the ears 32 of the spreader bars thereby to permit of adjusting, to a high degree of accuracy, the spacing of the sharp edges 31 of the blades 29 of the various spreader bars A, B, C and D with reference to the drum. This adjustment of these blades 29 is preferably such, that with the spreader bars A and B such quantity of glue drops back into the pan 14 as to provide a layer of glue on the drum of optimum thickness for drying, and with the spreader bars C and D this adjustment is preferably such that a small roll or accumulation of glue builds up, as indicated at 41, behind each of the blades 29 of these spreader bars C and D. The small excess of accumulated glue behind each of the blades 29 is preferably prevented from passing beyond the ends of the drum 6 by dam plates 42. As best shown in Fig. 3, these dam plates are preferably semicircular in form with their inner edges close to the periphery of the drum at the opposite ends thereof and these dam plates 42 are disposed against the opposing faces of the semicircular supporting plates 21. The small amount of glue passing around the ends of the blades 29 of the various

spreader bars B, C and D are caught by these dam plates 42 and build up in the form of a bead or ridge 37 of glue which travel along the opposing sides of these dam plates.

These beads or ridges 37 of glue (Fig. 5) are spread by a pair of short spreader bars 43, at the 3:00 o'clock position, each of which is mounted at the lower extremity of the corresponding semicircular supporting plate 21 on the descending side of the drum. In general, each of these short spreading bars 43 is generally similar to the long spreader bars A, B, C and D except for being shorter in length since their only function is to spread this small ridge or bead 37 of glue built up at each of the dam plates 42. Thus, in Figs. 3 and 8 each of the spreader bars 43 is shown as having a pair of alined spaced hubs 44 and 45 which straddle the extremity of the corresponding semicircular supporting plate 21 and are rotatably mounted on a stub shaft 46 projecting through this semicircular supporting plate. A blade 48 projects radially from each of the hubs 44 and 45 and has its working edge beveled and serrated, as indicated at 49, to provide a serrated edge 50 arranged in close proximity to the drum surface. The hub section 44 has an apertured ear 51 projecting radially therefrom, the position of this ear being determined by a swing bolt 52 extending through this apertured ear and journalled on the corresponding semicircular supporting plate 21. To this end, each swing bolt 52, as best shown in Fig. 3, has a backing nut 54 and a wing nut 55 arranged on opposite sides of the apertured ear 51 and the end of this swing bolt is anchored in the enlarged head 56 of a bolt 59 which extends through the corresponding semicircular supporting plate 21 and is held in position by a nut 60.

The layer 20 of glue, with the ridges provided by the serrations 17 and 50 of the spreader bars D and 48, is removed from the surface of the drum 6 by a doctor blade 61. This doctor blade is of the usual form having a sharpened edge 62 directed in opposition to the moving surface of the drum so as to strip the dry layer 20 of glue therefrom. This doctor blade is shown as mounted, by means of a backing plate 63 and screws 64, to a doctor blade holder 65 having a shaft 66 the opposite ends of which are journalled in bearings 68 on the trunnion stands 1 and 2 of the dryer. The pressure of the edge 62 of the doctor blade 61 against the drum is adjusted by means of the pair of arms 69 fastened to the ends of the shaft 66 and each having its free end engaged by a manual adjusting screw 70 as best shown in Fig. 2. Each of these manual adjusting screws is threadedly mounted in a holder 71 carried by the corresponding trunnion stand 1 or 2, a conventional form of this doctor blade adjustment being shown.

It will be seen that the letters A, B, C and D also represent stations at which the layer 20 of glue on the drying drum 6 are progressively manipulated and which follow the layer applying station represented by the periphery of the applicator roll and are followed by the layer removing station represented by the doctor blade 61.

Operation

In the following description of the apparatus it is assumed that it is operating under normal running conditions. It will be appreciated that in setting up for such normal running condition adjustments of the applicator roll 10, spreader bars A, B, C and D and short spreader bars 43 are required to obtain the desired build up of glue on the rolls or bodies therebehind and, in the case of the applicator roll 10 and spreader bars A and B, the desired return of glue to the pan 14.

In drying bone or hide glue with the apparatus as above described, it is desirable to concentrate the glue to the maximum practical point, such as is presently practiced, before admitting it to the feed pan 14. It is also desirable that the glue in the feed pan 14 be maintained at a temperature that will not impair the gel characteristics of the glue. This temperature of the glue in the pan 14 is maintained in the range of from about 110° to 160° F. The applicator roll 10 is preferably cooled to prevent overheating of the glue, the temperature of this applicator roll 10 being preferably maintained by the circulation of cooling water therethrough, at a constant temperature of from about 90° to about 125° F.

In general, prolonged heating, especially at high temperatures, tends to reduce the gel strength or quality of the higher grade glues. Therefore the drum temperature should be at the lower end of the effective range. Also if the moisture is removed too rapidly, it leaves a spongy flocculent layer on the drum. Low drum temperature allows the moisture to be released and collect under the skin that forms on the outer surface of the layer of glue. This skin is broken and redissolved at the spreader bar stations B, C and D, releasing the accumulated vapor and allowing further drying between each station and at the same time at each spreader station any craters or spongy spots in the layer are filled in with the glue, progressively becoming more concentrated, that gathers at each spreader station.

In addition to the pan temperature, that is, the temperature of the body 15 of glue in the feed pan 14, the steam pressure in the drying drum 6 and hence the temperature thereof is critical in producing a dense product. This steam pressure is variable depending on the grade of glue being dried and is preferably maintained in the range of from about 10 to about 35 pounds gage pressure or at from about 240° to about 280° F., although the invention has been successfully practiced with the steam pressure of 3 pounds gage (222° F.). Practice of the invention indicates that the lower the steam pressure the denser and higher the gel strength of the product. Also it has been found that the optimum pan temperature and steam pressure depends on the grade of glue. Thus, the higher the grade of glue, the lower the temperature in the feed pan 10 and steam pressure in the drum 6 which should be used. With high grade hide glue it has been found that a pan temperature of about 120° F. and a steam pressure of about 15 pounds gage (250° F.) produces satisfactory results.

As best indicated in Fig. 3, a thick layer of glue is picked up from the body of glue 15 in the pan 14 by the applicator roll 10 and this layer carried up the rising side of this applicator roll 10 to the rising side of the heated drying drum 6. A body of glue builds up between the applicator roll 10 and the drum 6 a part of which is carried away by the drum and the balance of which rolls back into the pan 14. The applicator roll 10 is kept at a moderate temperature lower than the feed temperature in the pan 14 to assist in preventing overheating of the glue in the pan 14. The layer of glue 20 is accordingly applied to the rising side of this heated drum 6, and this layer 20 is successively subjected to the action of the four full length spreader bars A, B, C and D.

During passage from the applicator roll 10 to the first spreader bar A, the glue is concentrated to a point beyond that which is practicable in a standard evaporator and during this passage as an excessively thick layer between the applicator roll 10 and the first spreader bar A, the glue rapidly concentrates. On reaching the first spreader bars A and B the layer 20 is excessively thick and a large quantity of this glue is removed as excess by these initial spreader bars A and B and falls back directly into the pan 14. By far the greater part of this returned glue is returned by the first spreader bar A.

On leaving the first spreader bar A, the layer of glue 20 gathers into heavy streaks and into a lacy network of raised veins interspersed with globs so that the layer of glue becomes of highly irregular contour. Also a skin quickly forms on this layer and if left undisturbed this layer of glue would dry unevenly because of its highly irregular contour but more important the skin so formed on the surface of the layer would act as a barrier to retard the escape of moisture from the under part of the layer.

Even at the lower steam pressure employed in the drying drum 6, the moisture so trapped in the glue by the skin on the exterior of the layer would break the skin and result in a spongy, fluffy, or flocculent product of low density which could be redissolved by the user only with great difficulty.

This highly irregularly contoured and skin coated layer 20 of the glue then reaches the second spreader bar B. The edge 31 of the blade 29 of this spreader bar B is set away from the drum less than the thickness of the layer 20 approaching the blade 29 of the second spreader bar B. Accordingly, the blade 29 of the spreader bar B levels off the tops of the thick streaks, veins and globs and fills the glue so leveled off into the valleys between these streaks, veins and globs so as to reform the layer 20 of glue into a layer of more uniform thickness. As previously indicated, the setting of the spreader bar B is such as to remove a substantial excess from the drum 6, this excess falling back into the pan 14.

On leaving the spreader bar B, the leveled off layer again gathers into heavy streaks and into a lacy network of raised veins interspersed with globs so that the layer of glue again becomes of highly irregular contour. Also a skin again quickly forms on the layer and if left undisturbed this layer of glue would dry unevenly because of its highly irregular contour and also because the skin so formed would act as a barrier to prevent the escape of moisture from the under part of the layer. This moisture trapped by the skin would break the skin and result in a flocculent low density product which could be redissolved by the user only with great difficulty.

This reformed highly irregular contoured and skin coated layer 20 of glue then reaches the third spreader bar C. The edge 31 of the blade 20 of this spreader bar C, as with the following spreader bar D, is set very slightly less than the mean thickness of the layer 20 passing under its blade 29. Accordingly the blade 29 of the spreader bar C levels off the tops of the thick streaks, veins and globs and fills the glue so levelled off into the valleys between these streaks, veins and globs so as to reform the layer 20 of glue into a layer of more uniform thickness. Since the blade 29 of this spreader bar C, as with the following spreader bar D, is set from the surface of the drum 6 very slightly less than the mean or average thickness of the film passing under the blade 29, a slight excess of glue builds up as a roll 41 behind the blade 29 of this spreader bar and rotates in the direction of the arrows associated with this roll in Fig. 4. The skin formed on the surface of the layer 20 of glue in approaching the spreader bar C is caught by this rolling roll 41 of glue behind the blade 29 of this spreader bar and is redissolved into this roll. This breaking and removal of the skin again allows moisture collected below the skin to escape and the roll also fills in the bare, spongy and veined areas on the drum. Accordingly, the layer of glue leaving the blade 29 of the spreader bar C is smooth and free from the skin formed on approaching this spreader bar and the moisture in the film is free to escape.

Any excess of glue removed by the blades of the spreader bars C and D travels to the ends of these bars. At these ends of these bars there is a slight clearance between these blades and the dam plates 42 as well as the slight clearance between these blades and the drum 6. A small amount of glue is drawn through these clearances and forms a bead or ridge 37 at opposite ends of the layer 20 as best shown in Fig. 5.

As the layer 20 of glue leaves the blades 29 of the spreader bars B and C where the glue is still quite dilute, some glue adheres to the bevel 30 of the blade 29 and extends therefrom in the form of a trailing flap 72 which rides on the leaving layer 20 of glue to prevent the skin from reforming immediately on this layer, thereby allowing the moisture to escape more freely for a longer period between the spreader stations B, C and D. This flap or trail 72, as shown in Fig. 5, is of irregular outline along its free or trailing edge and as it builds up to an excessive extent at any part of its length, this part breaks away from the flap and travels on the layer 20 of glue to the next spreader bar C or D where it is caught in the revolving roll 41 of glue behind the blade 29 of this spreader bar C or D and redissolved.

This trailing flap 72 plays an important part in obtaining a high density product. It prevents immediate exposure of the layer of glue 20 leaving the blade 29 of each of the spreader bars B and C and at the same time permits the escape of vapor from under its trailing edge. Accordingly, a skin cannot form on the layer 20 of glue while passing under this trailing flap 72 on the blades 29 of the spreader bars B and C and at the same time the vapor generated by the heat applied to this flap covered part of the layer 20 is free to escape from under the flap instead of being trapped immediately by skin formation.

The same skin forming and puckering action takes place as the layer 20 of glue on the drying drum leaves each of the spreader bars A, B and C, the layer, however, progressively becoming more dense and uniform. Also as this skin coated and puckered layer reaches the next succeeding spreader bar B, C or D the layer is reworked and smoothened and the skin broken and redissolved. Thus, on leaving spreader bar A and the trailing flap 72 of glue adhering to the blade 29 of each of the spreader bars B and C, a skin forms on the surface of the layer 20 of the glue on the drum 6 and the glue also gathers into a lacy network with veins, streaks and globs of glue defining valleys in the surface of the layer 20, this layer, however, becoming more uniform as the layer leaves each successive spreader bar. Also, on encountering each of these spreader bars B, C and D, a revolving roll 41 of progressively more concentrated glue builds up behind the blade 29 of the spreader bar and fills in any voids or craters remaining in the layer, as well as breaking and redissolving the skin.

As previously indicated, the last spreader bar D preferably has the edge of its blade provided with the serrations 17. These serrations tend to form ridges in the highly concentrated layer of glue leaving the spreader bar D. With these ridges a greater surface of the layer is exposed to facilitate the escape of moisture. Also the dried sheet is ridged with the ridges thicker and more dense than if the sheet were unridged. The thinner division lines between these ridges also facilitate breaking up the film and while these division lines will have slightly less moisture content than the ridges, this condition equalizes in storage.

As previously noted, the blades 29 of each of the spreader bars A, B, C and D are adjusted away from the drum 6 to progressively build up a uniform dense layer. A slight amount of glue passes beyond the ends of the blades 29 of these spreader bars and forms a bead or ridge 37 at each end of the drum 6. When each bead reaches the blade 48 of the corresponding spreader bar 43, this bead is spread out to form a continuation of the layer 20 of glue on the drum. It has been found that the glue from these beads dries properly when handled in this manner due to the fact that the glue of these beads gets the same treatment by the blades 29 of the spreader bars A, B, C and D as the glue passing under these blades.

The layer of glue is thereafter removed from the drum by the doctor blade 61. This layer is removed from the apparatus above described in a dense ridged sheet that is slightly tacky. However, the layer so removed by the doctor blade quickly hardens into a brittle, dense product which can be readily ground or otherwise processed.

It will be seen that the drum 6 constitutes a smooth uninterrupted movable working surface adapted to carry a board liquid layer of substantial thickness; that the sheet will be of sufficiently uniform dryness to become brittle shortly after removal from the drum surface; that the applicator roll 10 and feed pan 14 constitute means arranged

to apply continuously to the drum or working surface the layer of glue solution to be dried without subjecting it to prolonged high temperatures; that the doctor blade **61** constitutes means arranged to remove the dried layer from the movable working surface or drum and that the spreader bars A, B, C and D constitute at least a pair of blades arranged operatively intermediate and in spaced relation to said layer applying means and layer removing means and in spaced relation to each other and each operating to intermittently break the skin forming on the layer together with an adjacent portion of the liquid glue, to gather the so removed skin and adjacent portion into a mass and effect redissolution of said removed skin, and to redistribute this redissolved gathered mass to fill in the valleys between the veins and globs and reform the layer into a smooth increasingly concentrated layer of substantially uniform thickness.

The following are specific examples of the practice of the invention in drying glue of the grades indicated. In these examples the figures for viscosity represent millipoises and the figures for gel strength represent gram weight as described in theh Standard Method for Determining Gel Strength of Glue published by the National Association of Glue Manufacturers.

Example I

The glue in the feed pan **16** was a high grade hide glue having a gel strength of 390, a viscosity of 103, a moisture content of 67.97% and was supplied to the feed pan at 142° F. The temperature of the water supplied to the applicator roll **10** was 102° F. and the steam pressure maintained in the drying drum **6** was 14 pounds' gage so as to maintain this drum at a temperature of about 248° F. The drum speed was 0.75 R. P. M. The layer **20** of the glue became brittle on leaving the doctor blade **61**. This removed product had a moisture content of 12.14% and was removed by the doctor blade in the form of flakes which weighed 15 pounds per cubic foot. The capacity of the dryer was 1.11 pounds per square foot of drum surface per hour. The dried product had a gel strength of 382, a pH of 6.3 and a viscosity of 103.

Example II

The glue in the feed pan was a medium grade hide glue having a gel strength of 180, a viscosity of 56, a moisture content of 60.45% and was supplied to the feed pan at 132° F. The temperature of the water supplied to the applicator roll **10** was 100° F. and the steam pressure maintained in the drying drum **6** was 14 pounds' gage so as to maintain this drum at a temperature of about 248° F. The drum speed was 0.75 R. P. M. The layer **20** of glue became brittle on leaving the doctor blade **61**. This removed product had a moisture content of 12.96% and the weight of the flaked product was 27.2 pounds per cubic foot. The capacity of the dryer was 1.35 pounds per square foot per hour. The dried product had a gel strength of 178, a pH of 6.5 and a viscosity of 57.

Example III

The glue in the feed pan **16** was a high grade hide glue having a gel strength of 380, a viscosity of 117, a moisture content of 62.57% and was supplied to the feed pan at 126° F. The temperature of the water supplied to the applicator roll was 110° F. and the steam pressure maintained in the drying drum **6** was 17 pounds gage so as to maintain this drum at a temperature of about 252° F. The drum speed was 2.25 R. P. M. The layer **20** of glue became brittle on leaving the doctor blade **61**. This removed product had a moisture content of 11.9%. The capacity of the dryer was 2.0 pounds per square foot per hour. The dried product had a gel strength of 387, a pH of 7.0 and a viscosity of 107.

Example IV

The glue in the feed pan **16** was a vegetable glue. Steam pressure maintained in the drying drum **6** was 3 pounds gage to maintain this drum at a temperature of about 222° F. The drum speed was 0.75 R. P. M. The capacity of the dryer was about 0.6 pound per square foot of drum surface per hour. The moisture content of the dry material could be varied between 11% and 13.6% by varying the clearance between the spreader bars A, B, C and D and the drum. The bulk weight of the dried material of the different moisture contents was approximately 32 and 38 pounds per cubic foot, respectively, after grinding through a coarse screen.

It will be appreciated that especially with vegetable glues which vary greatly in consistency, viscosity and gel strength, the feeding and spreader stations can be advantageously relocated and the invention is therefore not to be construed as limited to the feed and spreader stations located specifically as shown. Thus, with one vegetable glue it was found desirable to feed at the 8:00 o'clock position (Fig. 3) the fresh material being fed into the space between the feed roll **10** and the drum **6** by a pendulum feed as described in Patent No. 2,129,329. With this glue, the spreader bar A was located at 11:00 o'clock and the spreader bar B at 2:00 o'clock positions. Behind these spreader bars the vegetable glue gathered in a revolving roll **41** as with the animal glue. A film formed over the surface of the layer and a narrow flap **72** formed at the spreader bar A. Sections of this flap would break off at irregular intervals and heavy drops were formed on the drum between spreader stations A and B to be removed and gathered into the revolving roll **41** behind the spreader bar B. At the spreader bar B the material formed into a smooth, uniform coating which dried out uniformly and was removed by the knife **61** at 4:00 o'clock.

Other arrangements can be made by adding additional spreader bars between 2:00 and 5:00 o'clock and locating the knife **61** between 4:00 and 10:00 o'clock. Location of the feed roll **10** can be between 7:00 and 1:00 o'clock. The optimum positions will depend on the properties of the material being dried, particularly the adherence of its solution to the hot drum surface.

By reducing the steam pressure from 18 pounds' to 3 pounds' gage (Example IV), it was possible to apply a coating with the feed roll at about 7:30 o'clock and the three spreader bars A, B, and C at 3:00, 12:00 and 9:00 o'clock positions respectively.

From the foregoing it will be seen that the present invention provides a high capacity simple and readily controlled method for drying bone and hide glue, particularly high grade hide glue, the drying of which has heretofore been accomplished with the use of expensive apparatus occupying a great deal of floor space, or by a process requiring special treatment. It will further be seen that the product of the process is dense and in satisfactory condition for use and that the invention accomplishes the various objects set forth.

I claim:

1. The method of drying an aqueous solution of glue which solution is characterized by forming a skin on exposure to the air and which skin acts as a barrier to prevent the escape of water vapor from the body of the solution and said solution also being characterized by said skin gathering into veins and globs, which comprises providing a heating zone maintained at a temperature to evaporate moisture from said solution, forming said solution into a smooth liquid layer of substantially uniform thickness exposed on one side to the atmosphere, moving said layer through said heating zone and in which zone a skin forms on said one side of said skin and said skin is drawn into veins and globs, continuously removing the skin together with an adjacent portion of the liquid glue from said layer at a first station along said heating zone

and gathering said removed skin and adjacent portion of the liquid glue into a co-mingled mass, agitating said gathered mass to effect redissolution of said skin, thereafter redistributing said gathered mass to reform said layer into another smooth liquid layer of substantially uniform thickness on one side of which reformed layer a second skin forms and said second skin is drawn into veins and globs, repeating at at least one succeeding station downstream along said moving layer from said first station said steps of continuously removing the skin together with an adjacent portion of the liquid glue from the layer, gathering said removed skin and adjacent portion of liquid glue into a co-mingled mass, agitating said gathered mass to effect redissolution of said skin, and redistributing said redissolved gathered mass to again reform said mass into still another smooth liquid last reformed layer of substantially uniform thickness, and removing said last reformed layer from said heating zone at a station downstream along said moving layer from the last of said succeeding stations.

2. The method set forth in claim 1 wherein each of said agitating steps is effected by revolving the gathered mass.

3. The method set forth in claim 1 wherein the temperature of said heating zone is maintained between about from 222° F. to about 280° F.

4. The method set forth in claim 1 with the additional initial step of preheating the glue solution to a temperature of from about 110° to about 160° F., and wherein the temperature of said heating zone is maintained at from about 222° to about 280° F.

5. The method set forth in claim 1 with the additional initial steps of preconcentrating the glue solution and preheating said solution to a temperature of from about 110° to about 160° F., and wherein the temperature of said heating zone is maintained at from about 222° to about 280° F.

6. The method set forth in claim 1 wherein the temperature of said heating zone is maintained in the order of 250° F.

7. The method set forth in claim 1 with the additional initial step of preheating the glue solution to a temperature of from about 110° to about 160° F. and wherein the temperature of said heating zone is maintained in the order of 250° F.

8. The method set forth in claim 1 with the additional initial steps of preconcentrating the glue solution and preheating said solution to a temperature of from about 110° to about 160° F., and wherein the temperature of said heating zone is maintained in the order of 250° F.

9. The method of drying and producing flakes from an aqueous solution of glue on the heated revolving drum of an atmospheric drum dryer and which solution is characterized by forming a skin on exposure to the air and which skin acts as a barrier to prevent escape of water vapor from the body of the solution and said solution also being characterized by said skin gathering into veins and globs, which comprises applying said solution as a smooth liquid layer of substantially uniform thickness to the periphery of said revolving drum, introducing steam into said drum to heat said layer on which a skin forms on its exposed side and said skin is drawn into veins and globs, obstructing movement of the surface portion only of said layer at a first station axially across the periphery of said drum to continuously remove an excess of the liquid glue from said layer at said first station, returning said excess glue to the original solution, obstructing movement of the surface portion only of said layer at least one succeeding station downstream along said moving layer axially across the periphery of said drum to continuously remove the skin formed on said layer together with an adjacent portion of the liquid glue from said layer, continuously gathering at each said succeeding station the removed skin and an adjacent portion of liquid glue into a revolving co-mingled mass, revolving and agitating said gathered mass to agitate said mass and effect redissolution of said skin, and continuously redistributing said last redissolved gathered mass to reform said mass into another smooth liquid layer of substantially uniform thickness, and removing said layer from said revolving drum at a station downstream along said layer from the last of said succeeding stations.

10. The method set forth in claim 9 wherein the steam is introduced into the drum at a pressure of from about 3 to about 35 pounds gage pressure.

11. The method set forth in claim 9 with the additional initial step of preheating the glue solution to a temperature of from about 110° to 160° F., and wherein the steam is introduced into the drum at a pressure of from about 3 to 35 pounds gage pressure.

12. The method of drying an aqueous solution of glue which solution is characterized by forming a skin on exposure to the air and which skin acts as a barrier to prevent the escape of water vapor from the body of the solution and said solution also being characterized by said skin gathering into veins and globs, which comprises providing a heating zone maintained at a temperature to evaporate moisture from said solution, forming said solution into a smooth liquid layer of substantially uniform thickness exposed on one side to the atmosphere, moving said layer through said heating zone and in which zone a skin forms on said one side of said skin and said skin is drawn into veins and globs, continuously removing the skin together with an adjacent portion of the liquid glue from said layer at one station along said heating zone and gathering said removed skin and adjacent portion of liquid glue into a co-mingled mass, agitating said gathered mass to effect redissolution of said skin, redistributing said redissolved gathered mass to reform said mass into another smooth liquid layer of substantially uniform thickness, holding a flap of partially dried glue derived from said layer in contact with the otherwise exposed surface of said reformed layer leaving said one station to prevent exposure of said reformed layer to the air and permit the escape of moisture from said reformed layer leaving said first station, repeating at at least one succeeding station downstream along said moving layer from said first station said steps of continuously removing the skin together with an adjacent portion of the liquid glue from the layer gathering said removed skin and adjacent portion into a co-mingled mass, agitating said gathered mass to effect redissolution of said skin, and redistributing said redissolved gathered mass to again reform said layer into still another smooth liquid layer of substantially uniform thickness and removing said last reformed layer from said heating zone at a station downstream from the last of said succeeding stations.

13. The method set forth in claim 12 with the additional step of preheating the glue solution to a temperature of from about 110° to about 160° F., wherein the temperature of said heating zone is maintained at from about 222° to about 280° F.

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