Jan. 1, 1952

A. W. DE VOUT

2,581,081

GLUE DRYING PROCESS

Filed March 29, 1947

3 Sheets-Sheet 1

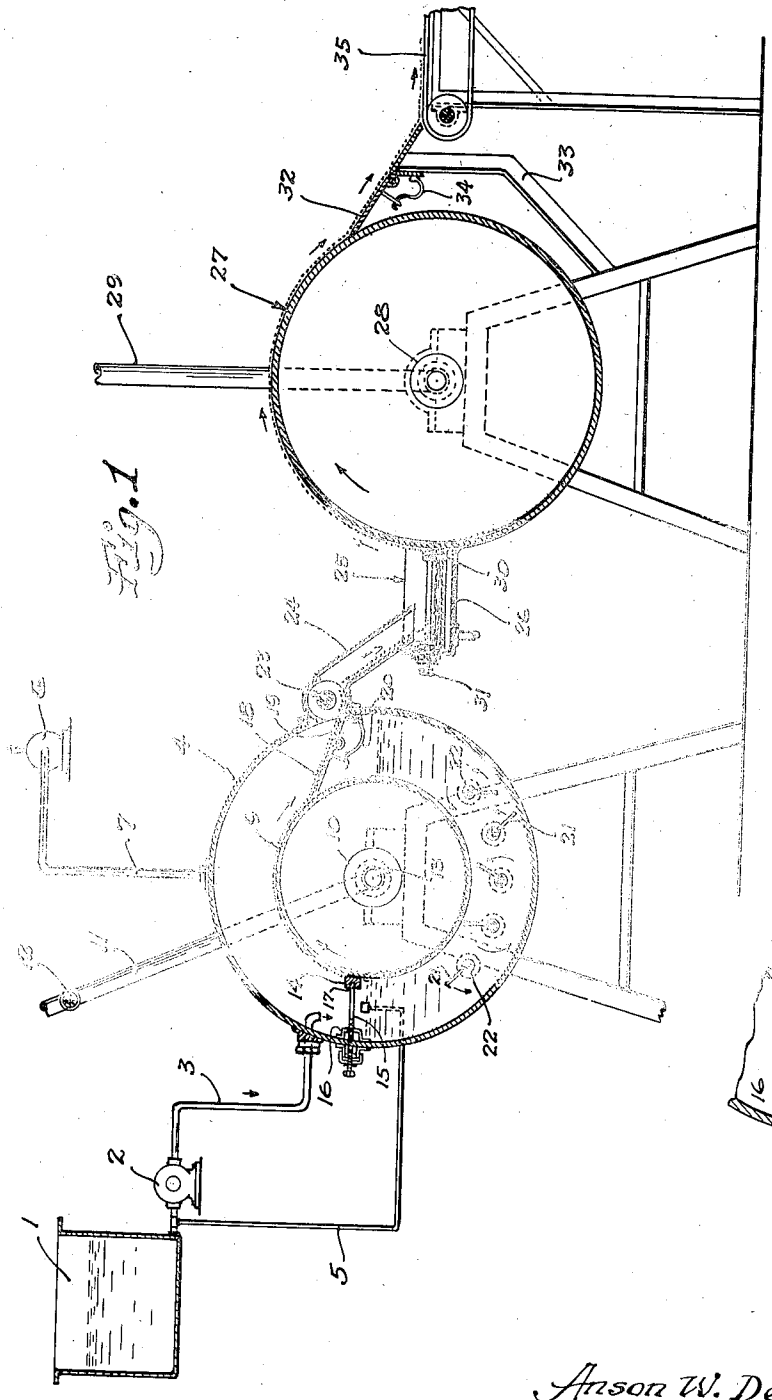

Fig. 1

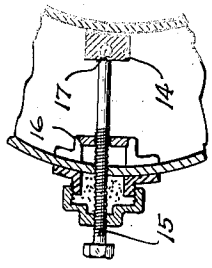

Fig. 2

INVENTOR.
Anson W. DeVout.
BY
R. J. Story
ATTORNEY

Jan. 1, 1952 A. W. DE VOUT 2,581,081

GLUE DRYING PROCESS

Filed March 29, 1947 3 Sheets-Sheet 2

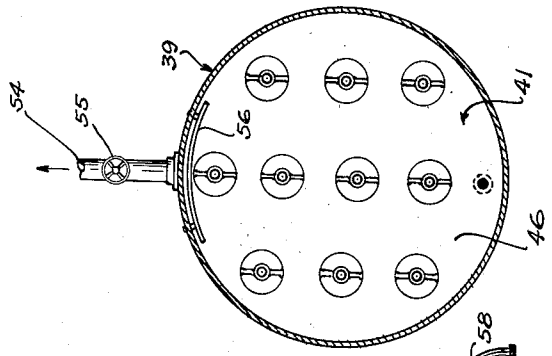

Fig. 4

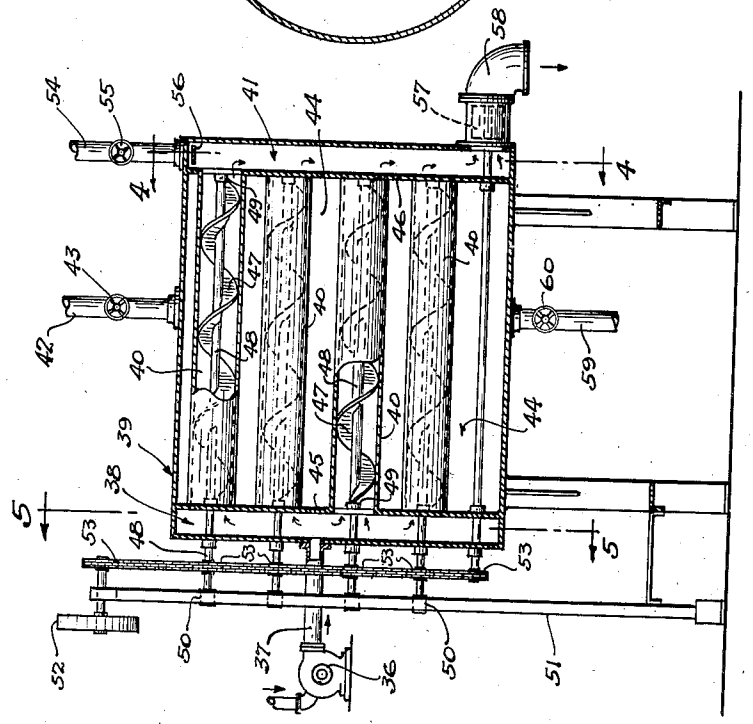

Fig. 3

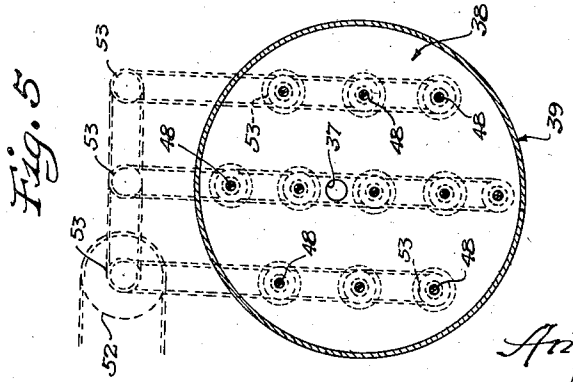

Fig. 5

INVENTOR.
Anson W. DeVout.
BY
R. B. Story
ATTORNEY

Jan. 1, 1952

A. W. DE VOUT

2,581,081

GLUE DRYING PROCESS

Filed March 29, 1947

3 Sheets-Sheet 3

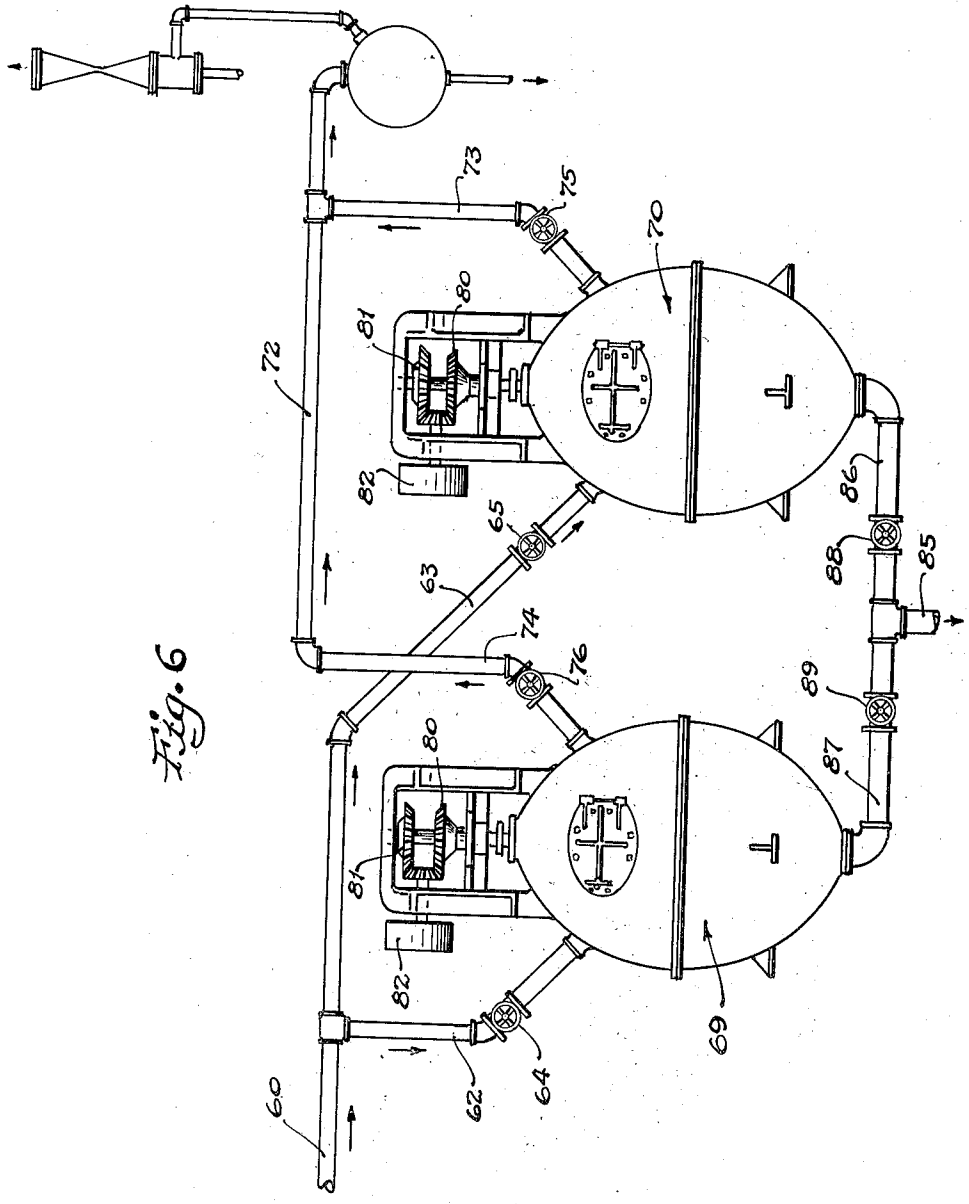

Fig. 6

INVENTOR.
Anson W. DeVout
BY
R. G. Story
ATTORNEY

Patented Jan. 1, 1952

2,581,081

UNITED STATES PATENT OFFICE

2,581,081

GLUE DRYING PROCESS

Anson W. De Vout, La Grange, Ill., assignor to Swift & Company, Chicago, Ill., a corporation of Illinois

Application March 29, 1947, Serial No. 738,035

13 Claims. (Cl. 159—49)

1

This invention relates to a process for drying gelatinous material, the term "gelatinous material" being employed in this specification and the appended claims as including both glue and gelatin. The invention relates more particularly to a process for drying glue or gelatin under year-around atmospheric conditions and thereby dispensing with the use of air conditioning.

Under long known and customary practices, animal glues and gelatins are manufactured by processes and apparatus so substantially the same in principle, at least so far as they require consideration in connection with the process of the present invention, as to render it sufficient to specifically refer here in the main to the manufacture of glue.

Glue, like gelatin, is generally extracted from the raw materials, such as animal bones and hides, in the form of a solution or glue liquor. Under customary practice, the extracted glue liquors are then evaporated in well-known types of vacuum pans or other evaporators to certain percentage concentrations of their solid contents which have become fairly standard in this industry, the average concentration of the solids for hide-glue liquors being generally about 22% on a weight basis, for bone-glue liquors about 35%, and for gelatin liquors about 15%.

The next steps in the manufacture of both the glue and the gelatin have been to spread the concentrated glue or gelatin liquors into a relatively thin, continuous layer or film and chill the same into the gel state, then cut the gelled layer of the material into suitable lengths and subject them to a drying operation upon stacked supporting nets, reticulated trays or the like in a drying tunnel, generally under air conditioning by either increase or decrease in the normal temperature and/or decrease in the humidity of the air employed as the gaseous drying medium, depending on the normal temperature and humidity of the air at the time.

Generally considered, all of the above-described procedural steps constitute the well-known and customary process of manufacture of glue or gelatin as the finished product. Since, however, the above-described step of concentrating the glue or gelatin liquor in well-known types of evaporators contributes to some extent to the final drying of the product, it may be said that the above-described steps, following the extraction of the glue or gelatin liquor from the raw materials, of concentrating the extracted liquors, congealing the same and air-drying the gel are all steps in the process of drying the extractions of glue or gelatin.

It has been found, however, that in the climate of the industrial cities of this country where glue and gelatin manufacturing establishments are mainly located, and of which cities New York and Chicago may be taken as fairly typical, difficulty is frequently encountered during the summer months in drying the extractions of glue and gelatin by the above-described customary methods. That difficulty is due to the fact that during the summer months in the mentioned localities the wet-bulb temperature of the air frequently becomes higher than the melting point of the gel, as produced for such drying by the above-described customary methods of concentrating the glue or gelatin liquor and then congealing the same. It then becomes practically impossible to properly dry the gel and complete the manufacture of the product due to a melting and running of the layers of the formed gel upon and into adhering contact with the supporting nets, trays or the like or into adhering contact of layers or other formed pieces of the glue or gelatin with one another.

2

The melting point of a glue or gelatin jelly is a function of the jelly-making strength of the glue or gelatin liquor as expressed in the so-called Bloom test and the concentration of the solids in those liquors. For example, the Bloom test for gelatin, expressed in the same form as that for glue, is considerably higher than the Bloom test of good hide glue or the best bone glue; and it is customary not to concentrate the extracted gelatin liquor to as high a point as for either hide or bone glue liquor. Likewise, hide glue, being usually of higher quality than bone glue and usually having a higher Bloom test, does not require as high a concentration of the solids in the extracted glue liquor as in the case of bone glue liquor prior to chilling the glue liquor for production of the gel and air-drying of the latter.

The foregoing factors are customarily taken into consideration in the hereinbefore mentioned customary evaporations of the extracted gelatin and glue liquors to a concentration of about 15% solids for the gelatin liquor, about 22% solids for the hide-glue liquor and about 35% solids for the bone-glue liquor. But, as hereinbefore stated, with such concentrations of the glue and gelatin liquors, the gels produced therefrom have melting points sufficiently below the wet-bulb temperature of the drying air frequently occurring in the summer months in the mentioned localities of glue and gelatin manufacture as to cause the beforementioned difficulty in the drying of the gel.

My invention is particularly directed to a solution of that difficulty in the final air-drying of the gels formed from the extracted glue and gelatin liquors. My invention is based on the discovery that under suitable precautions in the evaporation of glue and gelatin liquors, percentage concentrations of the solids in the range of approximately 35% to 70% by weight can be attained without substantial depreciation in Bloom test and that such percentage concentra-

tions will sufficiently raise the melting points of the gels formed from such concentrated glue and gelatin liquors above any wet-bulb temperature of the drying air apt to be encountered even in the summer months as to enable the successful drying of the gels without conditioning the air by way of lowering its normal temperature or humidity or conditioning it in any other respect.

Any percentage concentration of the solids within the above-mentioned range of approximately 35% to 70% may be said to be generally operative for the purposes of the invention whether the concentration be of the glue or gelatin liquors. But, the preferable concentrations are approximately 60% to 70% for bone-glue liquor extracts, approximately 50% to 65% for hide-glue liquor extracts, and approximately 35% to 50% for gelatin liquor extracts; and those preferable concentrations have been found to give remarkably efficient results in the drying of the gels formed from such liquors.

In general, it may be said that experience has shown that the maximum concentrations of solids attainable through evaporator methods and apparatus such as heretofore employed for the concentration of glue and gelatin liquors are considerably below the percentage concentrations given above for the glue and gelatin liquors by the process of the present invention. Those relatively low concentrations of prior practices appear to have been due mainly to difficulty in removal of water under the conditions of very substantial increase in viscosity with increase in solids concentration. For example, the viscosity of bone-glue liquor at 50% solids and 150° F. is about twenty poises while at the same temperature and a solids concentration of 67% its viscosity is nearly seven hundred poises. Experience has shown that with the methods and evaporators heretofore used for the concentration of glue and gelatin liquors, as those liquors become more concentrated in solid content their greatly increased viscosity causes the formation of a thick stagnant film or layer adjacent the employed heating surface, with consequent very substantial lowering of the rate of evaporation of the liquors and decomposition of their glue or gelatin-forming constituents by heat hydrolysis.

In one of its broad or general aspects, the present invention avoids the last above-mentioned objectional features of the prior art practices in the manufacture of glue and gelatin by forcibly advancing the extracted glue or gelatin liquor in a relatively thin, continuous stream, layer or film in contact with a heating surface for limited time intervals of actual contact of successive portions of the advancing body of the liquor with the heating surface, forcibly scraping the heating surface in the path of the advancing liquor to prevent adherence of material thereto, and controllably coordinating the temperature of the heating surface with respect to the time of contact therewith of each of the successively advancing portions of the continuous stream, layer or film of the glue or gelatin liquor. Thus the process of my invention avoids such stagnations and overheating of that liquor as to result in substantial loss in values of its glue or gelatin-forming constituents while at the same time my process effects evaporation of that liquor to the extent required to give it the hereinbefore-mentioned optimum percentage concentration of solids in the approximate range of from about 35% to 70%.

The thus concentrated glue or gelatin liquor may then be congealed in well-known manner and by the use of well-known apparatus into slabs, layers or other forms of the gel convenient for its final air-drying and dried without air conditioning at any season of the year.

Any one of various apparatus differing in specific details of construction and capabilities of functioning may be employed in performance of my process invention, provided, of course, that such apparatus have the mechanical means suitable for use in the practice of that invention.

For example, in one specific mode of practice of my process invention under its general principles as already given above, the employed heating surface may itself be a moving one supportably advancing the glue or gelatin liquor in a continuous thin layer or film of that material from a point of its disposal on the moving surface to a point of its discharge therefrom. And that mode of practice of my process invention may be successfully performed in an apparatus of the type known generally in the art as a vacuum drying roll when such apparatus is operated under proper conditions determinable by varying the steam pressure inside the roll, thickness of the layer or film of the glue or gelatin liquor on the roll and rotational speed of the roll.

Figure 1 of the accompanying drawings diagrammatically represents such an apparatus, mainly in transverse vertical section, suitable for use in the last-mentioned mode of practice of my process invention.

Figure 2 is an enlarged view of the means in Figure 1 for distributing the film of glue or gelatin on the drying drum.

In another specific mode of practice of my process invention under its general principles as already given above, a fixed or stationary heating surface may be employed, or a plurality of such heating surfaces, and the glue or gelatin liquor is then forcibly advanced in a turbulent stream flow in contact with such surface or surfaces. For that mode of practicing my process invention, I preferably employ an evaporator having a number of heated tubes equipped with rotating liquor-agitating and surface-scraping blades, and with the apparatus arranged for pump circulation of the glue or gelatin liquor through the tubes, and with means for removal of vapors without substantial entrainment therewith of any of the value solids of the liquors undergoing the treatment.

Figure 3 of the accompanying drawings diagrammatically represents an apparatus of the last-mentioned type, mainly in longitudinal vertical section, and suitable for use in the last above-mentioned mode of practice of my process invention;

Figure 4 is a transverse vertical section of the apparatus of Figure 3, along the line 4—4 of Figure 3;

Figure 5 is a vertical sectional view of the left-hand end of the apparatus of Figure 3, along the line 5—5 of Figure 3; and

Figure 6 is a vertical elevational view of an alternative type of apparatus for carrying out the concentrating operation in utilizing the well-known Dopp type of vacuum stills.

The structural features and capabilities of operation of the apparatus of Figure 1 will be sufficiently indicated in connection with the following description of the use of that apparatus in the practice of my process invention.

The glue or gelatin liquor as extracted from

the source materials in well-known manner is supplied from any suitable reservoir of that liquor such as shown in Figure 1 at 1, by pump 2 and pipeline 3 to the stationary cylindrical vacuum chamber 4 to a predetermined level in that chamber controlled by an automatic level control 5, which predetermined level of the liquor in the vacuum chamber 4 being indicated by the dotted line in Figure 1. The vacuum chamber 4 is maintained under suitable subatmospheric pressure by vacuum pump 6 and pipeline connection 7. The means for maintaining a vacuum in chamber 4 are shown diagrammatically and may include means (not shown) to condense water vapor, such as a wet vacuum pump, for example a barometric condenser with dry air pump or air ejectors.

The drum 9 rotates in the vacuum chamber 4 on oppositely disposed and axially bored stub shafts 10 which have their adjacent ends spaced apart within the drum 9 and which stub shafts are suitably driven by means not shown. The drum is heated, prior to the introduction of the glue or gelatin liquor into the chamber 4, to an adjustably controlled temperature by steam delivered from any suitable source of supply through the supply pipe 11 controlled by the valve 12, and the pipe 13 extending through the axial bore of one of the stub shafts 10, the steam exhausting through the axial bore of the opposite stub shaft 10.

The drying drum 9 in rotating takes up from the body of the glue or gelatin liquor in the chamber 4 at the free upper level of that body a continuous layer or film of the liquid material, the thickness of which is determined by adjustment of the strip bar 14 toward and away from the adjacent ascending run of the heating drum by the rod 15 screw threaded through the fixed brackets 16 and rotatable in sockets 17 on the strip bar, the adjustment of the strip bar being by manual rotation of the rods in their supporting brackets.

The glue or gelatin liquor taken up as a continuous thin layer or film on the ascending run of the drying drum at the upper liquid level is continuously bodily carried along on the upper run of the drum to a predetermined point of discharge on the descending side of the upper run of the drum.

A scraper or doctor blade 18 is employed to effect the discharge of the layer or film of the glue or gelatin liquor from the upper run surface of the drum as well as to continuously scrape or wipe that surface against adherence of material thereto, the scraper blade being pivotally mounted on a bracket 19 and having a knife edge extending the length of the drum and pressed by the spring 20 into close engagement with the descending run surface of the drum above the liquid level in the vacuum chamber 4.

In the practice of my process invention by such an apparatus as illustrated in Figure 1, it is also advantageous to agitate the glue or gelatin liquor in the region thereof below its liquid level adjacent the lower run of the heating drum so as to avoid any possible stagnation of the liquor in that region and consequent possible damaging overheating of the liquor. To that end, a series of rotating mechanical agitators may be employed as diagrammatically illustrated in Figure 1, comprising paddles or blades 21 fixed to shafts 22 rotatably driven in any suitable manner not shown. The employed shafts 22 are so disposed and the blades 21 are

of such dimensions as to present the rotating blades in sufficiently close clearance with the lower run of the drying drum as to not only agitate the liquor in the bottom portion of the chamber and thereby prevent stagnation of the same adjacent the drying drum but also wipe the lower run of the drum against adherence thereto of solids from the liquor.

The steam pressure inside the drying drum, the degree of vacuum inside the chamber surrounding the drum, the thickness of the layer or film of the glue or gelatin liquor on the drum, and the rotational speed of the drum most suitable for evaporation of the liquor on the drum to the desired concentration of its solids within the hereinbefore-mentioned range of approximately 35% to 70% cannot be given in precise figures as they will vary with the qualities of the glue and gelatin liquors and the size of the drum.

However, with any known quality of glue or gelatin liquor and definite size of drum, operative conditions for the attainment of the primary object of the invention in the final air-drying of the glue or gelatin without air conditioning at any season of the year can readily be determined by adjustably varying the steam pressure supplied to the interior of the drum, rotational speed of the drum and the thickness of the layer or film of the liquor deposited on the drum.

Generally, the steam pressure and vacuum should be such to maintain the temperature of the thin film of glue or gelatin on the outer surface of the drum at about 165° F. For a drum of about 42'' in diameter and 7½' long, a rotational speed from 8 to 12 R. P. M., a steam pressure therein within the approximate range of 1 to 10 lbs. per square inch gage, a vacuum of 14 to 20 inches of mercury in the vacuum chamber and a comparatively thin film of liquor on the drum, will be found to be operable conditions for the evaporation of glue and gelatin liquor to a percentage concentration of its solids within the hereinbefore mentioned approximate range of 35% to 70%.

As hereinbefore stated, however, the most effective percentage concentration for the purpose of the invention will vary as between glue and gelatin liquors, being about 35% to 50% for gelatin liquor, about 50% to 65% for hide-glue liquor and as high as about 70% for bone-glue liquor. But those percentage concentrations for those different liquors can readily be attained by variably adjusting the rotational speed of the drying drum, the degree of vacuum in the vacuum chamber, and the thickness of the layer or film of liquor on the drum upwardly or downwardly from the adjustments as given above for general operative conditions.

It is particularly to be understood that in the above-described use of the apparatus of Figure 1 in the practice of the present invention, the gelatinous material as delivered from the drying drum 9 over the scraper blade 18 and through the screw conveyor 23 and pipe 24 is in the concentrated but still fluent liquid form as distinguished from solid flakes or the like of the gelatinous material.

One suitable form of apparatus, among other suitable ones, which may be employed for chilling the concentrate glue or gelatin liquor to the gel state is also illustrated in Figure 1 in association with the previously described apparatus, as will appear from the following description of the use

of the associated apparatus in the practice of the present invention.

The concentrated glue or gelatin liquor is delivered by the pipe 24 to the trough 25 which has a heating jacket 26 supplied with a suitable heating medium, which may be hot water, sufficient to maintain the body of the liquor in the trough 25 in substantially the same fluent condition of its delivery to the trough 25.

A drum 27 may be employed, which drum is rotatably driven by any suitable means, not shown, through oppositely disposed stub shafts 28 mounted in suitable journal bearings and supplied with a chilling medium through pipe 29 extending through one of the stub shafts 28. When such a chilling drum is employed, it takes up a layer or film of the concentrated liquor from the body of that liquor in the trough 25, the thickness of the layer or film of the liquor disposed on the drum being determined by a device, including the strip bar 30 and adjusting rods 31, of substantially the same character and capabilities of operation as the previously described device comprising the strip bar 14 and its associated elements.

In the rotation of the chilling drum 27, the concentrated glue or gelatin liquor in the trough 25 is continuously taken up in a continuous thin sheet of that liquor on the upper run of the drum and chilled to the gel state during the advance of that material on the upper run of the drum to the point of its discharge where the doctor or scraper blade 32, pivotally mounted on the stationary upright 33 and pressed by the spring 34 into close engagement with drum, delivers the material as a continuous thin sheet of formed gel from the descending side of the upper run of the drum to the conveyor 35. The thin, continuous sheets of the formed gel may then be cut on the conveyor 35 into suitable lengths for drying and delivered to a suitable drying apparatus which may be an air-drying tunnel or the like, such, for example, as shown in the Hoelscher and Tour Patent 2,198,617. The drying may then be done under normal atmospheric conditions of temperature and humidity at any season of the year and hence without the necessity of such air conditioning as is usually practiced in the use of such air-drying apparatus.

As hereinbefore indicated, the apparatus in Figures 3, 4, and 5 may be employed in another mode of practicing my process invention differing in certain details from the first described mode of practice of that invention when using the apparatus of Figure 1. And, as in the case of the Figure 1 apparatus, the structural features and capabilities of operation of the apparatus of Figures 3, 4, and 5 will be sufficiently indicated in connection with the following description of the use of that last mentioned apparatus in the practice of my method invention.

The glue or gelatin liquor as extracted from the source materials in well-known manner is delivered from any suitable reservoir of that liquor through the pump 36 and pipeline 37 to the initial liquor-receiving space 38 of the cylinder 39 and therefrom, under pump pressure, through the individual tubes 40 of the plurality of banks of tubes shown in Figures 3 and 4 to the final liquor-delivery space 41 of the cylinder 39.

Prior to the introduction of the glue or gelatin liquor into the apparatus, the tubes 40, and to a somewhat lesser extent the initial liquor-receiving space 38 and the final liquor-delivery space 41 of the cylinder 39, are heated to an adjustably controlled temperature by steam delivered into the top of the apparatus from any suitable source of supply through the supply pipe 42 and control valve 43 therein to a steam chest 44 formed in the central portion of the cylinder 39 about the tubes 40 and separated from the opposite end spaces 38 and 41 of the cylinder 39 by the vertical walls 45 and 46, respectively. The excess steam and condensate is withdrawn from the bottom through the line 59 controlled by valve 60.

As the glue or gelatin liquor is circulated under pump pressure from the initial liquor-receiving space 38 of the cylinder 39 through the heated tubes 40 to the final liquor-delivery space 41, turbulence is imparted to the stream of the liquor through the length of each of the tubes 40 by a spiral blade 47 extending through substantially the length of each such tube on shaft 48 rotatable in bearings 49 within the tube and extending rearwardly beyond the front boundary wall of the cylinder 39 for rotatable support in bearings 50 in a stationary framework 51. The shafts 48 may be rotatably driven by the system of pulleys, sprockets and chains, including the main driving pulley 52, the sprockets 53 on the shafts 48 and the connecting chains, diagrammatically illustrated in Figures 3 and 5, or by any other suitable means.

In selecting an apparatus of the general type illustrated in Figures 3, 4, and 5 for use in the practice of the present process invention, the apparatus is preferably one in which each blade in each of the tubes, such as the spiral blade indicated at 47 in Figure 3, is not only dimensioned longitudinally to extend through substantially the length of the tube, but is also dimensioned transversely of its shaft to execute a wiping contact with the interior wall of the tube during the rotation of the blade. Those blades may, therefore, be used not only to impart turbulence to the streams of the glue or gelatin liquor advancing through the heating tubes but also to wipe the interior surfaces of those tubes against adherence thereto of solids from the liquor.

Preferably the evaporation of the glue or gelatin liquor to the hereinbefore-mentioned percentage concentration of its solids within the approximate range of from 35% to 70% by weight is conducted under an adjustably controlled degree of vacuum or subatmospheric pressure by way of a suitable pipe connection, such as the pipe 54, having control valve 55, to a condenser, air exhaust pump or other vacuum-producing means. A baffle plate 56 mounted on brackets fixed to the interior wall of the cylinder 39 is used in the final liquor-delivery space 41 of the cylinder to prevent entrainment of any solids or liquids from the glue or gelatin liquor with the evolved vapors or gases being delivered through the pipe 54.

The streams of glue and gelatin liquor circulating under pump pressure through the heating tubes 40 are delivered from those tubes into the final liquor-delivery space 41 of the cylinder 39. Preferably a positive acting rotary pump 57 in outlet conduit 58 is employed for forceful delivery of the condensed glue or gelatin liquor from the final liquor-delivery space 41 of the cylinder 39. If desired, any portion of the liquor from outlet conduit 58 may be recycled by means not shown to the feed chamber 38 for reprocessing.

The operating condition for effective use of the apparatus of Figures 3–5 in the practice of my process invention are similar in general principles to the hereinbefore-described operating conditions for use of the apparatus of Figure 1 in

the practice of that invention. In the use of the apparatus of Figures 3–5, the degree of vacuum inside the heating tubes **40**, the transverse dimensions of the streams of the glue or gelatin liquor in those tubes, the length of the tubes and the speed of the stream flow through the tubes most suitable for evaporation of the liquor to the hereinbefore-mentioned concentration of its solids cannot be given in precise figures as they will vary with the qualities of the glue or gelatin liquor and the size of the apparatus, particularly in respect of the length and inside dimensions and hence the capacity of the heating tubes.

Generally, in the use of the apparatus of Figures 3–5 for the practice of my process invention, the steam pressure in the chest **44**, as in the case of the steam pressure in the drying drum **9** of the apparatus of Figure 1, should be such as to maintain the temperature of the glue or gelatin liquor at about 165° F.

Also in the use of the apparatus of Figures 3–5, the vacuum on the interior of the heating tubes **40** may be about 14 to 20 inches of mercury as in the case of the vacuum in the chamber enclosing the drying drum in the use of the Figure 1 apparatus.

Substantially the only factor additional to the foregoing two factors of steam pressure and degree of vacuum requiring adjustment in the use of the apparatus of Figures 3–5 in the practice of my method invention is the speed of flow of glue or gelatin liquor through the heating tubes, since the speed of flow of the glue or gelatin liquor through each tube of a given length determines the time duration of exposure of each portion of that liquor to the other factors of heat and vacuum having their effect on the evaporative of that liquor.

The time duration of the passage of any one portion of the stream of glue or gelatin liquor through any one of the heating tubes **40** may vary somewhat. For tubes each of the same suitable length in the apparatus of Figures 3–5, say approximately 6 to 8 feet, and of suitable inside diameter, say approximately 4 to 8 inches, so as to give sufficient capacity and easy flow of the liquor, the pumps **36** and **57** of the apparatus of Figures 3–5 may be so operated as to require about one-half to one minute for the traverse of any one point or portion of the stream of the glue or gelatin liquor through a heating tube. That will usually give a time duration of exposure of each portion of the liquor to the other mentioned factors of heat and vacuum, under the before-mentioned further conditions of turbulent flow of the liquor through the tubes and the constant wiping of the liquor-contacted surfaces of the tubes against deposit of solids, to give an amount of evaporation of the liquor condensing its solids to a percentage within the hereinbefore-mentioned range of approximately 35% to 70% as required for the general purpose of the invention.

It is to be understood, of course, that the foregoing refers to general conditions of use of the apparatus of Figures 3–5 operative for the general purpose of the invention in the air-drying of the finally formed gel without air conditioning at any season of the year whether the initial liquor extract to be evaporatively condensed be a gelatin liquor, a bone-glue or a hide-glue liquor.

However, with any known quality of glue or gelatin liquor such as a bone-glue or hide-glue liquor or a high quality gelatin liquor and definite size and capacity of apparatus of the type illustrated in Figures 3–5, particularly in respect to the heating tube **40**, operative conditions for the concentrations of those various liquors to the hereinbefore-mentioned optimum percentages of about 35% to 50% for the gelatin liquor, about 50% to 65% for the hide-glue liquor and about 60% to 70% for the bone-glue liquor, can readily be attained by adjustably varying, in the upward or downward direction from the figures as given above for general operating conditions, the steam pressure supplied to the steam chest **44**, the degree of vacuum on the interior of the heating tubes **40** and the operating speed of the pumps **36** and **57** and consequently the speed of circulation of the liquor through the heating tubes.

In the practice of my process invention by the apparatus of Figures 3–5, as in the case of the use of the apparatus of Figure 1, the gelatinous material is delivered from the apparatus in the concentrated but still fluent liquid form as distinguished from solid flakes or the like. Any suitable apparatus may then be employed for chilling the concentrated liquor to the gel form and then finally air-drying the gel without air conditioning at any season of the year. Among many others, such apparatus may include the chilling and final air-drying apparatus referred to in the hereinbefore-given practice of my process invention by the use of the apparatus of Figure 1.

While I have shown the apparatus in Figures 3, 4, and 5 as laid out with horizontal tubes, it is contemplated and, an fact, may be preferable from an operating standpoint, to use a vertical layout which is often superior on account of better separation of the liquid from the water vapor.

In Figure 6 I have shown an apparatus for concentrating the liquid in a Dopp vacuum kettle or still. Since the Dopp kettles are ordinarily operated batchwise, two or more of such kettles may be connected in parallel whereby the operation may be carried on continuously, one still being discharged and recharged while the other still is employed in vacuum concentration.

Referring to Figure 6, the glue or gelatin solution is introduced from a source of supply not shown through the line **60**. Line **60** connects with branches **62** and **63** controlled by valves **64** and **65** for introducing the solution into kettles **69** and **70**, respectively. The kettles **69** and **70** are jacketed for heating with a heating medium such as steam or other suitable heating fluid. The kettles are also connected with a source of vacuum from the line **72** and branch lines **73** and **74** controlled by valves **75** and **76**. The Dopp kettle is provided with stirring and scraping mechanisms which are operated in opposite directions by the gears **80** and **81** driven by a motor or other source of power **82**. The scraper continuously removes the film from the inside of the kettle while the stirrer maintains the contents in an agitated condition. The kettles are connected with a draw-off line **85** through the branch lines **86** and **87** controlled by valves **88** and **89**. Suitable conditions which ordinarily do not vary to a great extent from that described heretofore in connection with Figures 1 to 5 may be maintained in the kettles, the object being to concentrate the glue or gelatin liquor to about 35% to 70%, as explained heretofore. The concentrate that is charged through the line **85** may go to a suitable chilling and drying mechanism, such as shown in Figure 1, or any other well-known or preferred type of drier. As explained

before, the product discharged from the line 85 should be of the preferred concentration whereby the material may be dried without utilizing air conditioning.

Obviously, many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. The process of forming a dry gel from a liquor extracted from gelatinous material of animal origin, comprising advancing said liquor in the form of a thin, continuous layer on the upper run of a rotating drum through a predetermined extent of said upper run in a vacuum chamber, heating said drum and reducing the pressure in said drying chamber while coordinating the temperature of the heated surface and the time of contact to concentrate said liquor to a percentage weight concentration of its solids within the range of about 35 per cent to 70 per cent and a maximum temperature of 165° F., removing said concentrated liquor from said drying chamber, congealing a quantity thereof to the gel state by cooling below its melting point, and drying the formed gel with natural atmospheric air.

2. The process as defined in claim 1 further characterized by employing as said liquor extracted from gelatinous material a gelatin liquor wherein the said liquor on said drum is evaporated to a percentage weight concentration of its solids in the range of about 35% to 50%.

3. The process as defined in claim 1 further characterized by employing as said liquor extracted from gelatinous material a hide-glue liquor wherein the said liquor on said drum is evaporated to a percentage weight concentration of its solids in the range of about 50% to 65%.

4. The process as defined in claim 1 further characterized by employing as said liquor extracted from gelatinous material a bone-glue liquor wherein the said liquor on said drum is evaporated to a concentration of its solids of 60% to 70% by weight.

5. The process of forming a dry gel from a liquor extracted from gelatinous material of animal origin, comprising advancing a quantity of said liquor for a predetermined length of time in a turbulent flow over a stationary metal surface, and subjecting said liquor in its said flow as a thin film over the metal surface to a degree of vacuum and said metal surface to a degree of heat effective for the length of time of contact of said liquor with said surface to concentrate said liquor to a percentage weight composition of its solids in the range of approximately 35 per cent to 70 per cent while maintaining a maximum temperature of 165° F. in said liquor, congealing said concentrated liquor to the gel state and drying said gel with natural atmospheric air.

6. The process as defined in claim 6 and further characterized by employing as said liquor extracted from gelatinous material a gelatin liquor and by employing a degree of heat on said metal surface and a degree of vacuum on said liquor in its flow over said surface evaporating said liquor to a percentage weight concentration of its solids in the range of about 35% to 50%.

7. The process as defined in claim 6 and further characterized by employing as said liquor extracted from gelatinous material a hide-glue liquor and by employing a degree of heat on said metal surface and a degree of vacuum on said liquor in its flow over said surface evaporating said liquor to a percentage weight concentration of its solids in the range of about 50% to 65%.

8. The process as defined in claim 6 and further characterized by employing as said liquor extracted from gelatinous material a bone-glue liquor and by employing a degree of heat on said metal surface and a degree of vacuum on said liquor in its flow over said surface evaporating said liquor to a concentration of its solids of about 60% to 70% by weight.

9. The process of forming a dry gel from a liquor extracted from gelatinous material of animal origin which maintains the initial gel strength of said material comprising evaporating said liquor at subatmospheric pressure by contacting a thin film of the liquor with a heated surface while coordinating the temperature of the heated surface and the time of contact to concentrate said liquor to a percentage weight concentration of its solids within the range of about 35 per cent to 70 per cent and a maximum temperature of 165° F., chilling a thin continuous film of the concentrated liquor to a point slightly below its melting point to form a gel, and drying the formed gel with natural atmospheric air.

10. The process of forming a dry gel from a liquor extracted from gelatinous material of animal origin which comprises: raising the melting point of the gel to be formed from the liquor by concentrating said liquor above the conventional 22 to 35% by weight solids content to a solids content of about 35 to 70% while maintaining the initial gel strength of the material, by heating said liquor in film form at a temperature below a maximum of 165° F.; congealing said concentrated liquor to the gel state by cooling; and thereafter contacting the gel so formed with natural atmospheric air to completely dry said gel.

11. A process as in claim 10, wherein the liquor extracted from gelatinous material of animal origin is a gelatin liquor, and the solids content to which said liquor is concentrated is in the range of about 35% to 50%.

12. A process as in claim 10, wherein the liquor extracted from gelatinous material of animal origin is a hide-glue liquor, and the solids content to which said liquor is concentrated is in the range of about 50% to 65%.

13. A process as in claim 10, wherein the liquor extracted from gelatinous material of animal origin is a bone-glue liquor, and the solids content to which said liquor is concentrated is in the range of about 60% to 70%.

ANSON W. DE VOUT.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,033,737	Schwarts et al.	July 23, 1912
1,353,980	Yahn	Sept. 28, 1920
1,608,147	Vierling	Nov. 23, 1926
1,672,218	How	June 5, 1928
1,810,691	Van Marle	June 16, 1931
1,949,374	Johnson	Feb. 27, 1934
1,980,898	Abernethy	Nov. 13, 1934
2,087,788	Thal	July 20, 1937
2,198,617	Hoelscher et al.	Apr. 30, 1940
2,352,220	Overton	June 27, 1944
2,440,778	Maglaughlin	May 4, 1948