

March 27, 1951

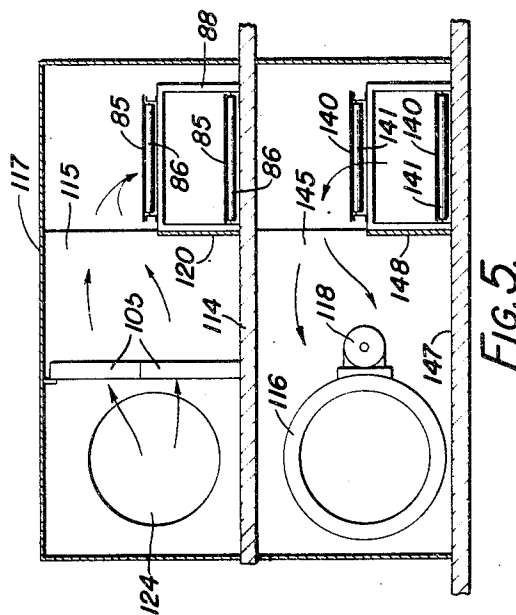
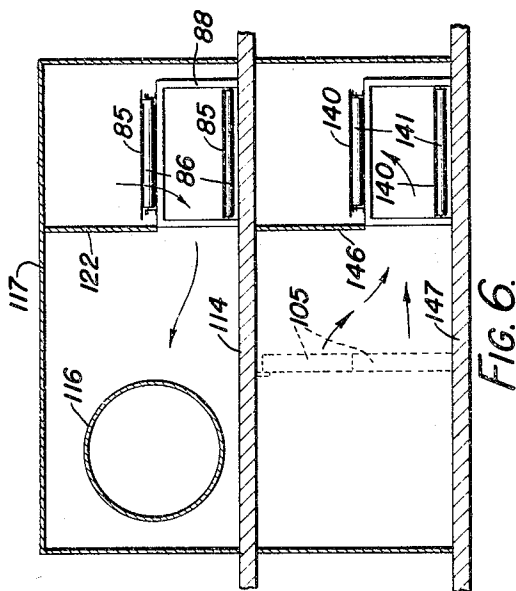
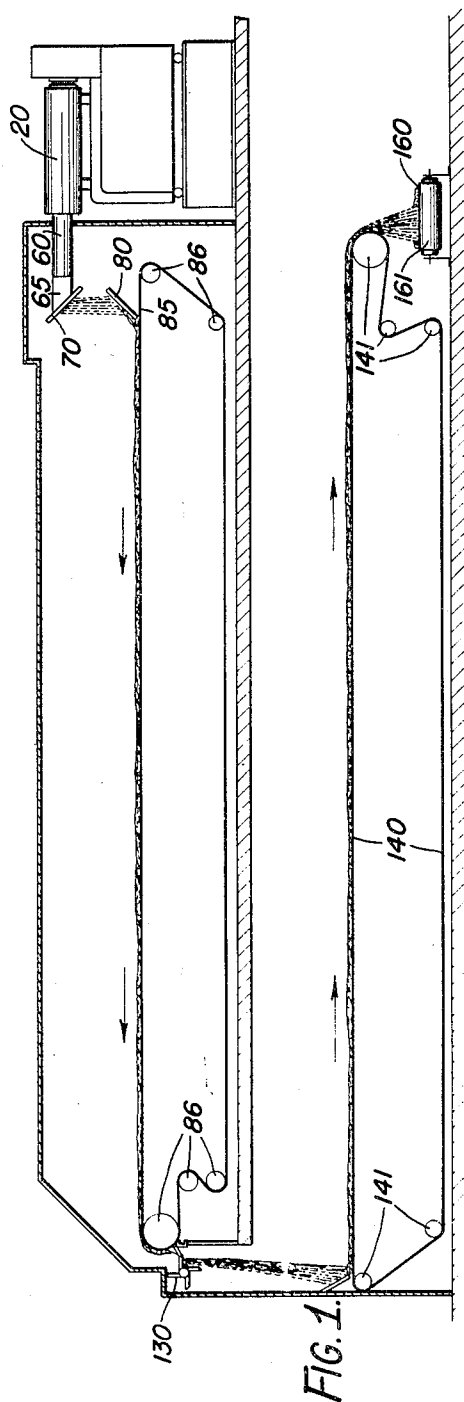
H. E. PECK

2,546,867

METHOD AND APPARATUS FOR DRYING GELATINOUS MATERIAL

Filed March 16, 1949

5 Sheets-Sheet 1



INVENTOR.
HENRY E. PECK

BY

B. Schlinger

ATTORNEY

March 27, 1951

H. E. PECK

2,546,867

METHOD AND APPARATUS FOR DRYING GELATINOUS MATERIAL

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5 Sheets-Sheet 2

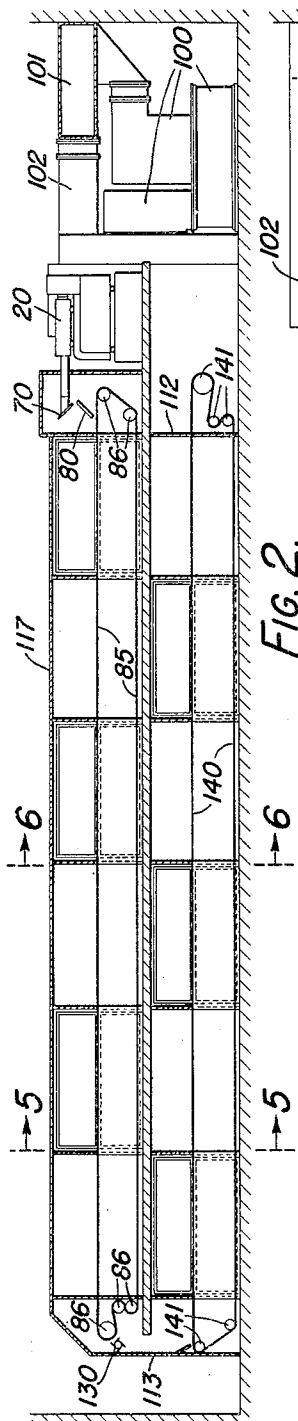


FIG. 2.

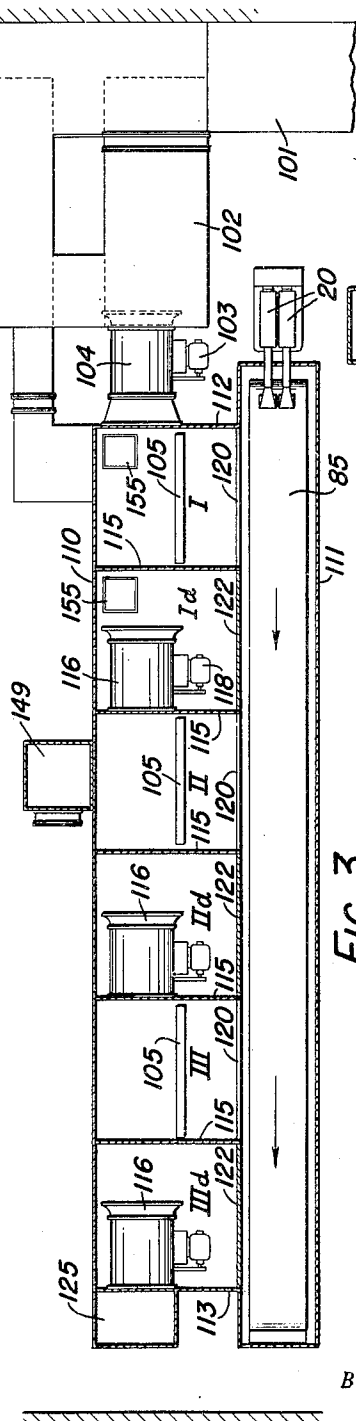


FIG. 3.

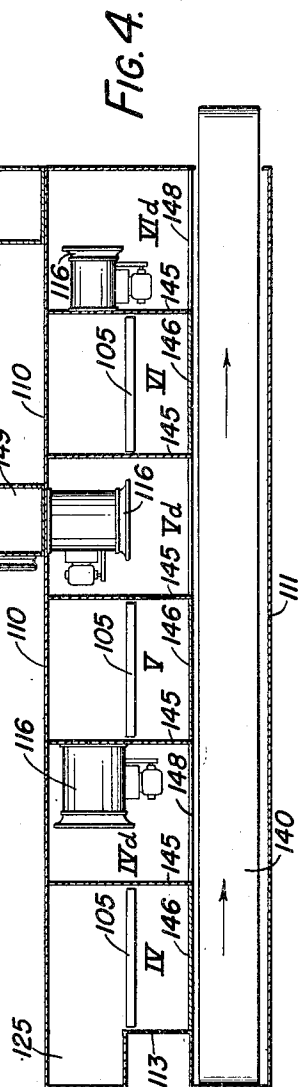


FIG. 4.

INVENTOR.
HENRY E. PECK

BY

ATTORNEY

March 27, 1951

H. E. PECK

2,546,867

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5 Sheets-Sheet 3

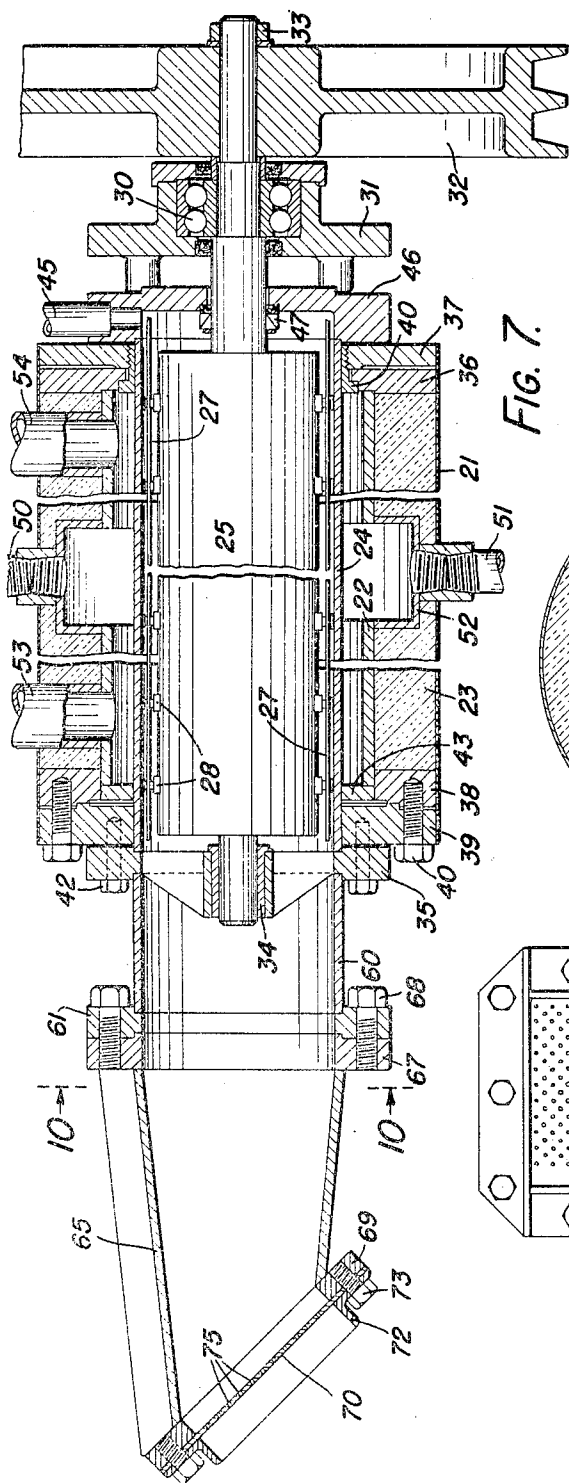


FIG. 7.

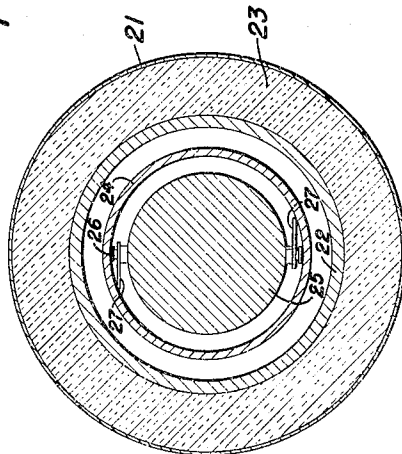


FIG. 9.

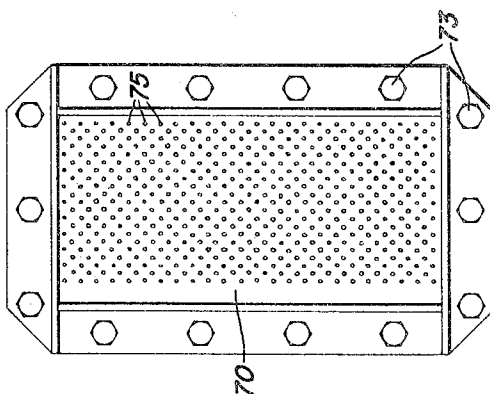


FIG. 8.

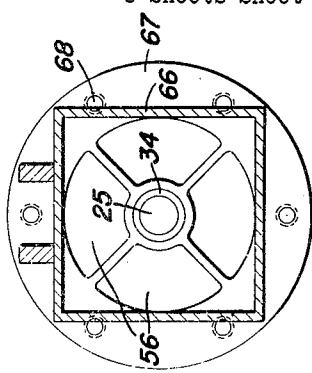


FIG. 10.

INVENTOR.
HENRY E. PECK

BY

W. H. Schaefer

ATTORNEY

March 27, 1951

H. E. PECK

2,546,867

METHOD AND APPARATUS FOR DRYING GELATINOUS MATERIAL

Filed March 16, 1949

5 Sheets-Sheet 4

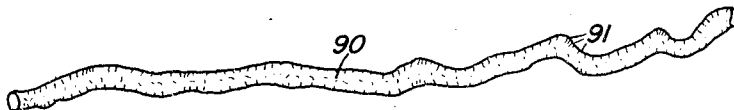


FIG. 11.

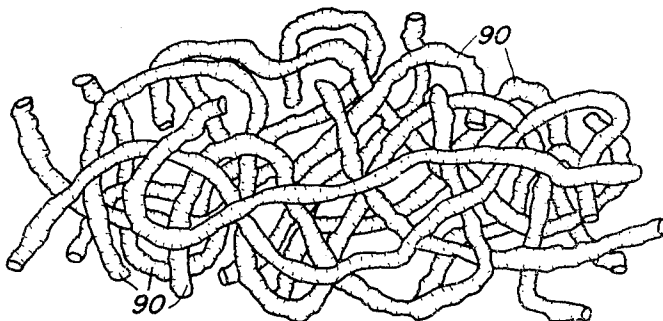


FIG. 12.

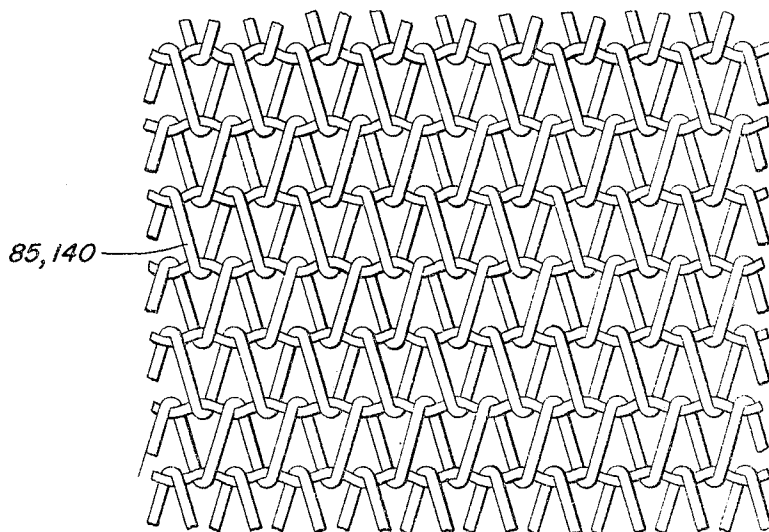


FIG. 13.

INVENTOR.
HENRY E. PECK

BY

W. H. Schlegel

ATTORNEY

March 27, 1951

H. E. PECK

2,546,867

METHOD AND APPARATUS FOR DRYING GELATINOUS MATERIAL

Filed March 16, 1949

5 Sheets-Sheet 5

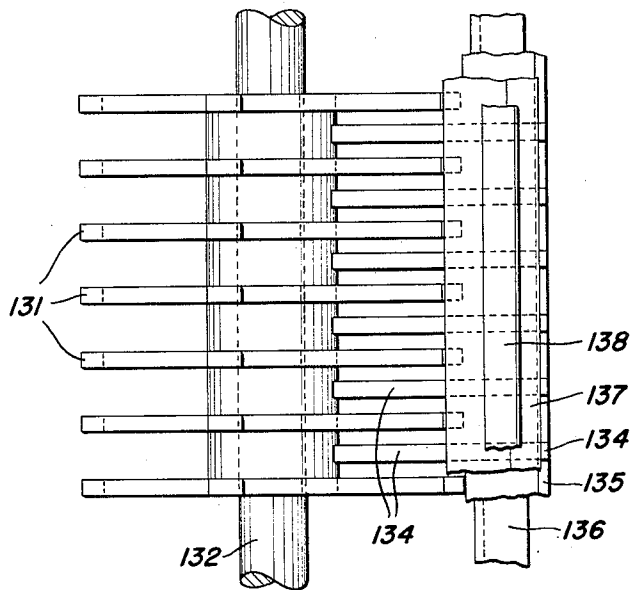


FIG. 14.

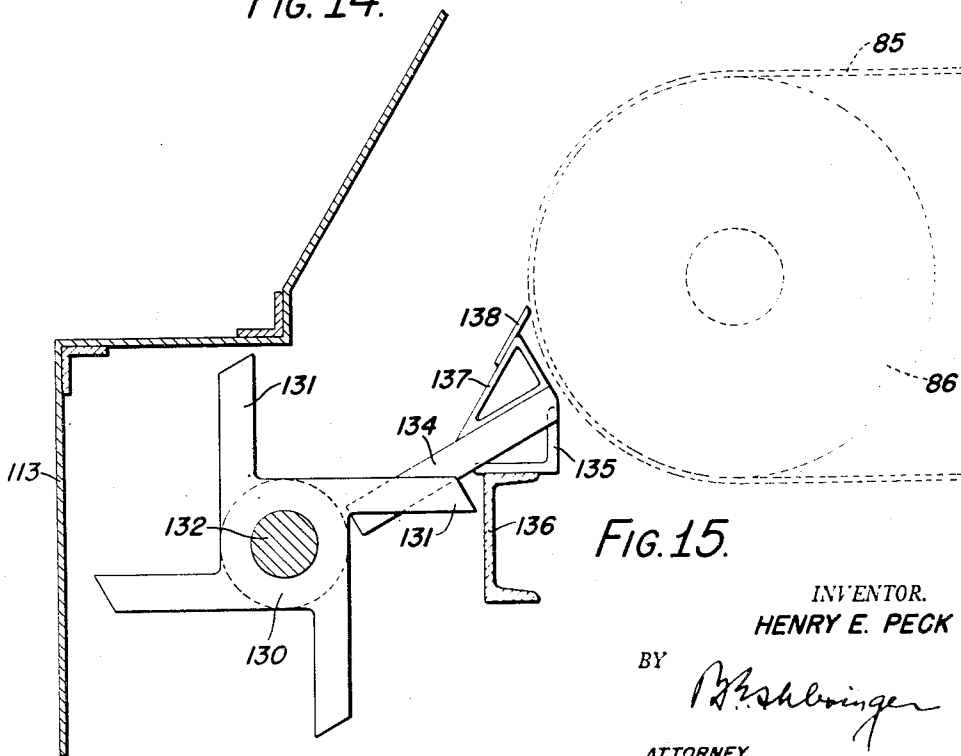


FIG. 15.

INVENTOR.
HENRY E. PECK

BY

W. Schloinger

ATTORNEY

UNITED STATES PATENT OFFICE

2,546,867

METHOD AND APPARATUS FOR DRYING
GELATINOUS MATERIALHenry E. Peck, Fairport, N. Y., assignor to Mc-
Bean Research Corporation, Rochester, N. Y.,
a corporation of New York

Application March 16, 1949, Serial No. 81,781

13 Claims. (Cl. 18—4)

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The present invention relates to the manufacture of glue and other gelatinous products and more particularly to the drying of animal glues and gelatins to condition them for shipment.

Gelatinous materials, such as animal glues and gelatin, are generally extracted from the raw material in the form of solutions which are first reduced to a jelly, and then dried to reduce the weight and bulk and to prevent deterioration of the product or growth of bacteria in the product during shipment. Bacteria forms in liquid glue at air temperature.

Various methods and apparatus have been developed for transforming the gelatinous materials from solution into a finished dried product.

The conventional method of drying glue is to pour the glue liquor into large rectangular pans and to set these pans in a cold room to jell. This requires for rabbit hide glue, for instance, about twelve hours. The blocks of jelled glue are then turned out of the pans and forced through a set of wires which slice the blocks into slabs. These slabs are laid out on wire netting stretched in square wooden frames. The frames are stacked in trucks with the frames spaced apart sufficiently for movement of air between them; and the trucks are wheeled into tunnels through which warm air is circulated to dry the slabs of glue. Aside from the number of manual operations involved in this method the chief disadvantage lies in the slow drying rate due to the relatively small surface presented for drying and to the fact that the air must be blown across the product and cannot be blown through it. It requires twelve or more hours to dry the glue in this fashion.

There have been several methods proposed for the continuous jelling and drying of glue, but those, with which we are familiar, involve a high capital investment and in some cases produce an inferior grade of product. Moreover, in prior types of continuous drying apparatus, the material has had to be stirred up more or less continuously either by men with rakes or tedders or mechanically while it is drying to prevent its sticking together and to assist the drying operation.

One object of the present invention is to provide an efficient, continuous process in which glue or any other gelatinous product may successively be jelled and dried in a continuous operation and without requiring any manual handling.

Another object of the invention is to provide a continuous process for jelling and drying gelatinous products in which a batch of glue or gela-

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tin can be dried in a relatively short period. To this end, a further object of the invention is to provide a process for depositing jelled glue in a porous mass on a conveyer or drying rack so that air may readily be blown through the mass to effect rapid drying.

A further object of the invention is to provide a process for the continuous jelling and drying of gelatinous products which can be performed with relatively simple apparatus and with a low capital investment.

Still another object of the invention is to provide apparatus for jelling and drying glue and other gelatinous products which is efficient, rapid in operation, and which will produce a product of very high grade.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims.

In the process of the present invention the glue liquor is first pumped through a heat transfer apparatus. This includes a central shaft which rotates in a cylindrical drum. On the central shaft are mounted scraper blades which scrape the inside of the drum. The diameter of the central shaft is but slightly less than that of the drum so that a thin annular space is formed between shaft and drum. Around the first drum is a larger drum forming a second annular space through which a suitable refrigerant such as ammonia, is pumped. The central shaft is rotated at any suitable speed usually 500 to 600 R. P. M.

The glue liquor is pumped into the inner annular chamber and becomes cooled rapidly due to a thin film which is constantly formed between the central shaft and inner drum and which is constantly scraped off the inner drum. The glue liquor actually becomes chilled in the heat exchanger to its jelling point but, due to the agitation of the blades, is prevented from setting into a jell until it leaves the heat transfer apparatus. The sub-cooled liquid is forced from the heat exchanger into an enlarged chamber, where it sets up into a jell. The jell is then forced through a perforated extrusion plate which continuously divides the jell into noodles of very small diameter. These noodles are not straight. The extruding plate is thin and has sharp-edged orifices. The jell compresses as it passes through the holes of the extrusion plate and then expands. The relief of the stresses causes the noodles to kink and bend and have roughened fractured surfaces. The noodles present therefore much more external drying area than a uniformly extruded shape would provide.

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The noodles drop from the extrusion plate onto the upper of two endless metal mesh conveyor belts which carry the noodles in opposite directions, respectively, through a continuous drying chamber. Outdoor air, suitably conditioned by means of air filters, heaters, and de-humidifying units, is supplied to the drying chamber. Each belt passes through a number of progressive drying zones. In each zone hot air is passed through the glue to pick up moisture from the glue. The air is reused repeatedly. After passing through the glue in one zone it is directed through heaters which raise its temperature so that when it passes through the glue again in the next zone the relative humidity is such that it will be able to remove additional moisture from the glue.

The drying air in the first zone of drying is always passed down through the glue and through the mesh conveyor belt. If the drying air came in from the bottom, the metal of the conveyor would be heated and the material lying on the conveyor would come up to the dry bulb temperature of the air. This would tend to melt the glue. Another reason for always sending the air down in the first zone is to hold the material on the belt. If the air was sent upward in the first zone, it would tend to lift the material off the belt and scatter it. After the material has dried a little it forms an interlaced and bonded mass which holds it down on the belt.

While the air goes downward in the first zone, in other zones, the air may be sent up through the glue to permit the material to be dried on its bottom so that it may readily be stripped off the belt at the end of the drying operation.

The air is repeatedly re-heated in each of the zones, following the first zone, to bring it up to the maximum temperature which can safely be used at that particular stage in the drying of the material. Each time that the air goes through the glue it drops about 10° to 20° due to evaporation. Each time that the air is re-heated its wet bulb temperature is higher due to the added moisture taken up from the glue.

The noodles tend to mat as they dry, so at the end of the first belt the noodles pass into a shredder which breaks them up again. The second belt travels at much less speed than the first belt. Since the material has been dried to a considerable degree in its travel on the first belt and has usually lost about 70% of its weight, the material can be loaded onto the second belt up to a much greater thickness than on the first belt.

The second belt, like the first belt, travels through several heat zones. In the next to the last zone, the air is taken out and discarded. In the last zone the air handled may be re-circulated. If the material is still sticky when it reaches the last zone the temperature of the air is set high enough in this zone to bake out the glue. If the material is overdry, the moisture content can be adjusted in this last zone.

At the end of the drying chamber the material may be continuously discharged into a crusher from which it is transferred to bins or otherwise treated for storage or further processing.

For rabbit hide glue, for instance, the entire drying from beginning to end can be done with the process and apparatus of the present invention in approximately one hour and forty minutes.

In the drawings:

Fig. 1 is a diagrammatic view in longitudinal section illustrating the process and the general structure of the apparatus of the present invention;

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Fig. 2 is a vertical sectional view on a reduced scale further illustrating the structure of the apparatus;

Fig. 3 is a plan sectional view of the apparatus showing particularly the upper floor of the drying chamber;

Fig. 4 is a plan sectional view of the apparatus showing particularly the lower floor of the drying chamber;

Fig. 5 is a section on an enlarged scale on the line 5—5 of Fig. 2 looking in the direction of the arrows;

Fig. 6 is a section on an enlarged scale on the line 6—6 of Fig. 2 looking in the direction of the arrows;

Fig. 7 is a longitudinal sectional view of the heat exchanger, and of the expansion chamber and extrusion plate associated therewith;

Fig. 8 is an elevational view of the extrusion plate;

Fig. 9 is a transverse sectional view of the heat exchanger;

Fig. 10 is a transverse section taken on the line 10—10 of Fig. 7;

Fig. 11 is a diagrammatic view of one of the noodles as extruded from the extrusion plate;

Fig. 12 is a diagrammatic view showing how the noodles intertwine as they are deposited on the belt, leaving spaces between them for passage of air therethrough;

Fig. 13 is a fragmentary plan view showing the structure of a mesh belt such as may be used in the apparatus of the present invention;

Fig. 14 is a fragmentary plan view on an enlarged scale showing the shredder which breaks up the material dropping from the first onto the second belt; and

Fig. 15 is a fragmentary vertical sectional view of the shredder and associated parts.

In the process of the present invention, glue solution at a concentration ordinarily of 20% to 40% solids is first pumped into the heat exchanger or exchangers. In the set-up illustrated there are two heat exchangers employed in order to deliver enough material for the width of conveyor belts used and the speed of movement of those belts. The two heat exchangers are identical in structure and are mounted side-by-side. Each is denoted as a whole at 20. Since they are identical in structure only one need be described in detail.

Each exchanger comprises a cylindrical jacket 21 (Figs. 7 and 9) within which is mounted a cylinder 22 that is insulated from the jacket by any suitable insulating material 23. Within the cylinder 22 there is mounted a second cylinder 24. Within the cylinder 24 there is journaled a shaft 25 which is of relatively large diameter between its ends. Secured to this shaft as by means of bolts 26 are a plurality of scraper blades 27. The bolts 26 may thread into bosses 28 formed on the periphery of the shaft 25.

The shaft 25 is of greatly reduced diameter at its ends, and is journaled at one end on an anti-friction bearing 30 in an end cap 31. There is a drive pulley 32 fastened to the projecting end of the shaft and secured thereon by a nut 33. The pulley may be driven from a motor (not shown) to impart rotation to the shaft 25. The opposite end of the shaft 25 is journaled on a plain bearing or bushing 34 in the end bearing support 35 (Figs. 7 and 10) of the heat exchanger.

The heat exchanger is closed at one end by plates 36 and 37 and at the opposite end by plates 38 and 39. The plate 37 threads onto a fitting

40 that is welded or otherwise secured to drum 24. Plate 36 is secured by welding or otherwise to the drum 22. The plate 39 is secured to plate 38 by bolts 40 and plate 38 may be secured by welding or otherwise to the drum 22. Bearing support plate 35 may be bolted by bolts 42 to plate 39. A plate 43 serves to close one end of the space between the drums 22 and 24. This plate may be welded to plate 38. The fitting 40 and plate 36 close the other end of this space. Gaskets may be provided where desirable to prevent leakage.

The gelatinous solution is pumped to the heat exchanger through pipe 45 to a header 46 that is bolted or otherwise secured to plate 37. The reduced right-hand end of the shaft 25 passes through a seal 47 in this header. Cap member 31 is bolted or otherwise secured to this header.

The refrigerant, which may be ammonia, may be supplied to the annular space between the drums 22 and 24 from the pipes 50 and 51 that thread into a drum section 52 which is welded or otherwise secured to the drum 22 and forms part thereof. The refrigerant is carried off at opposite ends of the annular space between drums 22 and 24 through the pipes 53 and 54.

The glue solution flows from the header 46 through the narrow annular space between the shaft 25 and the drum 24; and it is continuously agitated and swept off of the cold inner surface of the drum 24 by the scrapers 27 as the shaft rotates. The pressure of the liquid flowing into the header 46 from the pipe 45 forces the glue on through the heat exchanger. In the heat exchanger, the glue is rapidly cooled down below its jelling point because there is only a thin film of solution in contact at any time with drum 24. The glue is not allowed to set up, however, because of the agitation of the scrapers.

The sub-cooled liquid passes through the openings 56 in the end plate 35 of the heat-exchanger into an adaptor 60. This adaptor is welded at one end to end-plate 35 and at its opposite end to a plate 61.

Secured to the adaptor 60 is an extrusion nozzle 65 which is rectangular in cross-section. This nozzle tapers inwardly slightly from its entering to its leaving end. It is welded at its right hand end to a plate 67 which is secured by bolts 68 to plate 61. The left hand end of the nozzle is slabbed off and is secured by welding to a rectangular plate 69. The extrusion plate 70 is clamped to the plate 69 by a collar plate 72 and bolts 73.

The extrusion plate 70 is a relatively thin plate and has a plurality of small holes 75 there-through. The size and spacing of these holes, of course, varies with different jobs, but in a typical installation the holes would be $\frac{3}{8}$ " in diameter and spaced half an inch apart.

The adaptor 60 and nozzle 65 have cross-sections which are between 50 and 100 times the area of the passage in the heat exchanger. Hence, when the material comes out of the heat exchanger, the enlarged cross-sections of the adaptor 60 and nozzle 65 allow the material, which has been kept from setting up by the agitation of the blades in the heat exchanger, to set up. The pressure of the solution behind it forces this jelled material on to the extrusion plate. The material comes as a solid body of jell then, to the extrusion plate 70, and is extruded from the homogeneous mass of jell into solid ribbons. If the adaptor was of the same area as the heat exchanger, the material would be granulated instead of being formed into noodles.

As the jell passes through the holes in the extrusion plate it is compressed. As soon as it emerges from these holes, the stresses are relieved, causing the emerging ribbons of jell to kink and curl. The slabbed delivery end of the nozzle 65 inclines the extrusion plate 70 to the vertical as shown. The ribbons of glue drop from the extrusion plates 70 of the two cooling units then onto a distributor 80 (Fig. 1) which may be of any suitable construction. It may be, for instance, a small belt conveyer which is inclined to the vertical and which may be made to oscillate back and forth across the line of travel of endless belt 85 to distribute the noodles over the width of this belt.

The weight of the material dropping from the extrusion plates breaks the ribbons into noodles such as shown at 90 in Fig. 11. Because the material has been compressed in its passage through the holes of the extrusion plates and then expands freely in the air after such passage, the noodles are kinked and have fractures in their surfaces, as indicated at 91 which make for more rapid drying.

The size of the noodles will vary, of course, with the size of the holes 75 in the extrusion plate, the length of those holes, the material, etc. For rabbit hide glue with an extrusion plate $\frac{1}{8}$ " thick and having $\frac{3}{8}$ " diameter holes, the noodles are about $\frac{1}{8}$ " in diameter and three inches long. The minimum ratio of the length to the diameter of the noodles is about five to one.

The distributor 80 spreads the noodles, as they drop, over the belt 85 which is travelling at a slow enough rate to allow the desired thickness of noodles to be deposited upon it. Fig. 12 shows how the noodles deposit themselves upon the belt, intertwining with one another but leaving air spaces between through which the drying air may pass. The noodles are deposited on the belt 85 to a thickness of one and a half to two inches. If too great a thickness of noodles is laid on this belt the noodles will pack down, preventing air from circulating freely through the material, thus hindering drying.

The belt 85 carries the material into a drying chamber which in the embodiment illustrated comprises a two-story room whose side walls are denoted at 110 and 111 (Fig. 3) and whose end walls are denoted at 112 and 113. The roof of this room is designated 117 (Fig. 2).

The belt 85 itself is made of wire mesh so as to permit air to pass freely through it and through the material and may be of the type shown in Fig. 13.

As the gelatinous material moves along with the belt 85 through the drying chamber, hot air is passed through it to dry it. The air for drying the material is first properly conditioned by means of air filters, heaters, de-humidifying units, and washers, these units being indicated generally at 100 (Fig. 2).

The belt 85 traverses the upper story of the drying chamber and is supported at required points along its length by rollers 86. One of these rollers is the driver and may be driven from a motor or other source of power. The rollers are journaled in brackets or frames 88 (Figs. 5 and 6) which are bolted or otherwise secured to the floor 114 of the upper story of the drying chamber. These frames support both the upper rollers, which carry the forward moving portion of the belt, and the lower rollers, which carry the returning portion of the belt. In the diagrammatic views of Figs. 1 and 2, some of the rollers

have been omitted because of the smallness of the scale.

Partitions 115, which project at right angles from side 110 of the room, divide the upper floor of the drying chamber into three drying zones each consisting of two compartments. These compartments are numbered I, Id, II, IId, III, IIId, respectively. Each of the compartments I, II and III are input compartments. Each of the compartments Id, IId, and IIId are discharge compartments. Mounted in the compartments I, II and III are heaters 105 which may be of any suitable construction. Mounted in compartments Id, IId and IIId are fans 116 of any suitable construction each of which may be independently motor-driven from motors 118 through a pulley and belt drive.

The washed, filtered, de-humidified, and heated air is drawn through the ducts 101 and 102 (Figs. 2 and 3) by a motor-driven fan 104 which may be driven by motor 103 through a belt and pulley drive. This fan drives the air through a set of heaters 105 in compartment I which heat the desiccated air up to the maximum wet-bulb temperature which can be used below the melting point of the jelly before the air passes through the mass of noodles on the belt 85.

The partitions 115 extend from wall 110 close to belt 85. Opposite each of the compartments I, II and III in the set-up illustrated there is a wall member 120 (Figs. 3 and 5) which extends across the width of the compartment between the two partitions 115, which define the compartment, and from the floor 114 up to just below the belt 85. These prevent the heated air from flowing in under the belt and direct it, so that as it is drawn on by any of the fans 116 it will go down through the material and through the belt.

Opposite each of the compartments Id, IId and IIId is a partition wall 122 (Figs. 3 and 6) which extends across the full width of the compartment and down from the ceiling 117 of the room to just below the upper forwarding moving part of the belt 85. These walls 122 prevent the fans 116 in each of the zones Id, IId, IIId from drawing the air through the top of the belt and compel it to travel downwardly.

As a result of this construction, the air, after passing through the heaters 105 in compartment I, is drawn by the fan 116 in compartment Id down through the belt 85. As the air passes down through the material on the belt it picks up moisture from the material.

In the drying of the glue it is highly essential that the wet bulb temperature at the inlet of any drying zone should not exceed the melting point of the glue; otherwise the glue would form into a solid block through which it would be impossible to blow air. As the dry air comes into contact with the noodles, however, a skin of relatively dry material is formed on the noodles giving them strength enough to sustain themselves. As the glue dries, then, it will withstand higher temperature, which will, of course, promote more rapid drying. The air will be cooled, of course, in going through the bed of glue so that it will be approximately at the wet bulb temperature after its passage therethrough. Thereby there is no tendency to melt the part of the glue which is in contact with the conveyor.

After passage of the air through the material in the first zone of travel of belt 85, the moist air is drawn from below the belt 85 by the fan 116 in compartment Id, discharged through an opening 124 (similar to that shown in Fig. 5) in the

left-hand partition wall 115 of zone Id, and driven through a second group of heaters 105 in compartment II. These heaters, which are set at a higher temperature than the heaters 105 of compartment I, raise the temperature of the moisture-laden air. The fan 116 in compartment IId pulls the further-heated air down through the material and down through the belt again and under the belt 85 as the belt moves past compartment IId, and drives the air into a third set of heaters 105 in compartment III. As the air passes through the material it, of course, picks up further moisture from the material and dries it still more. The temperature of the moisture-laden air is still further raised by the heaters in compartment III. The further-heated air is drawn from the heaters down through the belt again by fan 116 in compartment IIId. It again picks up moisture from the material and further dries the material.

The belt 85 may be of any desirable length and it may travel at any desirable speed. In a typical installation for drying rabbit hide glue a belt 85 is employed that is sixty feet long and that travels at the rate of three feet per minute so that it takes the material on the belt only twenty minutes to travel the length of the upper floor of the drying chamber and be subjected to three successive drying treatments while passing opposite zones I, II, and III.

The glue, as it dries tends to mat, so at the end of the belt 85, the mats of noodles are passed through a shredder which breaks up these mats.

This shredder may be of any suitable construction. As shown it comprises a rotating knife 130 (Figs. 14 and 15) having a plurality of blades 131 arranged about and along its axis. The knife is secured to a shaft 132 which may be driven in any suitable manner. The blades of the knife are adapted to pass between fingers or prongs 134 that are welded or otherwise secured to a bracket 135 which is mounted on one of the crossbeams 136 of the building. The mats of partially dried glue drop off of the belt 85 onto a downwardly inclined deflector plate 137 which is welded to the prongs 134. A scraper plate 138 may be welded to the deflector plate 137 to prevent the glue from being carried around with the belt.

The shredded material drops through the grate, which is formed by fingers 134, onto a lower belt 140 which rides over rollers 141. This belt travels in the reverse direction to the belt 85 and at slower speed, preferably at about half the speed of belt 85. Of course, due to the slower speed of travel of belt 140 the material will pile up higher on belt 140 than on belt 85. Since the material has been dried to a considerable degree in its travel on belt 85, however, and has lost about 70% of its weight, and has, moreover, a hard outer coating, it can be loaded on the lower belt 140 to a much greater thickness without matting. As an example, the material may be laid to a thickness of one and a half to two inches on the belt 85 and to a thickness of four inches or more on the belt 140.

The belt 140 travels the length of the lower floor of the drying chamber and may be of the same length as belt 85. The lower floor of the chamber is divided like the upper floor into six compartments denoted IV, IVd, V, Vd, VI, and VIId, respectively. Partition walls 145 which extend at right angles to the wall 110 of the building close to the belt 140 separate these compartments. The compartments IV, V and VI are inlet compartments and the compartments IVd, Vd,

VId are outlet compartments. Mounted in the inlet compartments IV, V, and VI are sets of heaters 105. Mounted in the discharge compartments IVd and Vd are fans 116; and mounted in the discharge compartment VId is a somewhat smaller fan 116'.

Opposite each of the inlet compartments IV, V and VI is a partition wall 146 (Figs. 4 and 6) which extends down from the ceiling 114 to just below the belt 140. Opposite each of the compartments IVd, Vd, and VId is a partition wall 148 which extends up from the floor 147 of the room to just below the top of the belt 140.

By the time the noodles have reached the lower belt 140 they are sufficiently dry that there is no longer any tendency for the material, which is in contact with this conveyor belt, to melt. It is desirable, however, to insure that this material contacting the belt is thoroughly dry at the end of the drying operation so that it may readily be stripped from the belt. For this purpose the direction of flow of the air through the material may be reversed on the lower drying floor. It may be sent up through the belt 140 and up through the material instead of down. The direction of flow of the air in any zone of the drying chamber is simply a matter of location of the partitions 120, 122, 146 and 148. In the first zone, zone I, however, the air flow should be downwardly through the material and the belt,

for the reasons already given. The moisture-laden air that is drawn through the material by the fan 116 of upper compartment IIId is driven by that fan into a duct 125 which delivers it to the set of heaters 105 in lower compartment IV. Its temperature is raised by these heaters; and it is drawn by the fan 116 in compartment IVd up and through the mass of material on the belt 140. It picks up further moisture from the material and further dries the material. Then it is forced by the fan 116 in compartment IVd through heaters 105 in compartment V, where its temperature is further raised. Then it is drawn by the fan 116 in compartment Vd once more up and through the material, picking up further moisture from the material and further drying the material.

By this time, the air is at or near its saturation point. So it is discharged by the fan 116 of compartment Vd into a duct 149 that leads to the outside air.

In the sixth zone comprising compartments VI and VId, final drying may be effected by recirculation of air in a substantially closed system. There are a set of heaters 105 in compartment VI and a fan 116' in compartment VId. The fan 116' is mounted in reverse position from the fan of compartments IVd and Vd. This fan 116' draws air up through the belt 140 and the material thereon into compartment VId and forces this air through the set of heaters 105 in compartment VI out under partition 146 whence it is again drawn by the fan up and through the belt and the material. Dampers 155 (Fig. 3) are provided in the floor 114. These can be opened or closed manually and independently of one another. Thereby, moist air may be drawn in from zone I to the recirculating system, or air may be discharged from the recirculating system into the main drying system. Complete control of the temperature and moisture-content of the air in the recirculating system in the sixth zone is therefore possible. If the material is still sticky when it reaches this zone, it can therefore be baked out by heating the air to a high temperature. If

the material is overdry, the moisture content can be adjusted.

By driving the air up through the material from below in the last zone or zones, the material contacting the belt can be dried so that it will freely leave the belt. This permits the material to be stripped off the screen mesh of the belt easier.

When the material reaches the end of the belt 140, it drops onto a belt 160 (Fig. 1) which is supported by rollers 161. Belt 160 may carry the now-dried material to a crusher from which it may be transferred into bins or otherwise treated for storage or for further processing.

From the preceding description it will be seen that with the process and apparatus of the present invention it is possible to dry glue in a very short time, automatically, with a minimum of attention, and with simple, relatively inexpensive equipment. The product is completely enclosed in highly sanitary surroundings during chilling and jelling from which air is completely excluded. Chilling and jelling are extremely rapid, minimizing the effect of destructive bacterial action during this stage of the process. The chilling and jelling apparatus itself, moreover, is easily cleanable and occupies a very small space.

In the drying operation, all new or outdoor air, properly filtered and desiccated to the required moisture content (approximately 40 grains of moisture per pound of air) is used.

The gelatin as it leaves the extrusion plates is in extremely friable form having a surface area, for rabbit hide glue, for instance, in excess of 10 sq. ft. per pound of material and is loosely knitted together so that drying air can be passed through the entire mass. The fact that we are able to blow air through the mass rather than across the top of it or the bottom of it enables us to dry large quantities of the glue in a relatively short time with a minimum of air flow.

The entire volume of air is discharged at the end of the main drying section just ahead of the final tempering zone. The air is discharged with a very high moisture content corresponding to the highest wet bulb temperature that the material can safely stand in its final drying stage, resulting in very economical drying.

This process of drying gelatinous materials has several advantages over other methods. The very rapid drying greatly reduces the danger of bacterial growth and contamination. The high ratio of surface area to volume of the gelatin in the noodle form and the effective utilization of this drying area in the drier construction permit large drying capacity in a relatively small space and with a high thermal efficiency. The progressive reheating air circuits permit the maximum utilization of a minimum of new outdoor air and the air has only to be desiccated once at the beginning of the cycle, resulting in a minimum of air-conditioning equipment as compared to other continuous driers. Air is discharged from the drier carrying more moisture than the wettest outdoor air in summer, eliminating any need for uneconomical redrying for recirculation. The manpower requirements of the drier, moreover, are very low as compared to practically all other drying methods.

With the present apparatus the smallest possible quantity of air is used with the lowest possible moisture content and the air is continuously reused. The air starts with forty grains of moisture per pound of air and ends up

with one hundred forty or more grains of moisture per pound. Other driers take twice as much air but add only about half as much moisture. With the present invention, moreover, the whole mass of material is dried to the same extent without agitation.

While the invention has been described particularly in connection with the drying of glue, it will be understood that it is applicable to the drying of any gelatinous material as, for instance, edible gelatin. Furthermore, while the invention has been described in connection with a particular embodiment thereof and a particular use therefore, it is to be understood that it is capable of further modification and use; and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth and as fall within the scope of the invention or the limits of the appended claims.

Having thus described my invention, what I claim is:

1. The method of producing gelatinous material which comprises cooling a solution of the material to the jelling point of the solution while agitating the solution to prevent it from jelling, forcing the sub-cooled solution into an enlarged chamber where it can jell, and then extruding the jell from the chamber in ribbons of small diameter.

2. The method of drying gelatinous material which comprises cooling a solution of the material to the jelling point of the solution while agitating the solution to prevent it from jelling, forcing the sub-cooled solution into an enlarged chamber where it can jell, extruding the jell from said enlarged chamber ribbons, and allowing the extruded ribbons of material to break of their own weight so as to form ribbons of much smaller diameter than length.

3. The method of processing gelatinous material which comprises spreading a solution of the material in a thin layer, cooling the layer to the jelling point of the material, while agitating the layer to prevent the solution from jelling, forcing the sub-cooled solution into an enlarged chamber where it can jell, and extruding the jelled solution from the chamber in ribbons of small diameter.

4. The method of producing gelatinous material which comprises cooling a solution of the material to the jelling point of the solution in a completely enclosed chamber from which air is excluded while agitating the solution to prevent it from jelling, forcing the sub-cooled solution into an enlarged chamber from which air is also excluded, allowing the solution to jell in said enlarged chamber, then extruding the jell from the chamber in ribbons, and allowing the extruded ribbons to break of its own weight so as to form ribbons of the material which are of smaller diameter than length.

5. The method of producing gelatinous material which comprises cooling a solution of the material to the jelling point of the solution in a completely enclosed chamber from which air is excluded while agitating the solution to prevent it from jelling, forcing the sub-cooled solution into an enlarged chamber from which air is also excluded, allowing the solution to jell in said

enlarged chamber, then extruding the jell from the chamber in ribbons, collecting the extruded material and passing heated air depthwise through the material to dry the material.

6. The method of drying gelatinous material which comprises cooling a solution of the material to the jelling point of the solution while agitating the solution to prevent it from jelling, forcing the sub-cooled solution into an enlarged chamber to permit it to jell, extruding the jelled material in ribbons, collecting the extruded material on a traveling foraminous conveyer, passing heated air repeatedly through the material depthwise of the material as it moves along with the conveyer, and raising the temperature of the air repeatedly after passage through the material prior to another passage of the air through the material.

7. The method of drying gelatinous material which comprises cooling a solution of the material to the jelling point of the solution while agitating the solution to prevent it from jelling, forcing the sub-cooled solution into an enlarged chamber to permit it to jell, extruding the jelled material in ribbons, collecting the extruded material on a traveling foraminous conveyer, passing heated air repeatedly through the material depthwise of the material as it moves along with the conveyer, and raising the temperature of the air after each passage through the material prior to the next passage of the air through the material, the air being passed down through the material at least on its first passage through the material.

8. The method of drying gelatinous material which comprises cooling a solution of the material to the jelling point of the solution while agitating the solution to prevent it from jelling, forcing the sub-cooled solution into an enlarged chamber to permit it to jell, extruding the jelled material in ribbons, collecting the extruded material on a traveling foraminous conveyer, passing heated air repeatedly through the material depthwise of the material as it moves along with the conveyer, and raising the temperature of the air after each passage through the material prior to the next passage of the air through the material, the air being passed down through the material at least on its first passage through the material and the air being passed up through the material at least on its last passage through the material.

9. The method of drying gelatinous material which comprises conveying a jelled gas-permeable mass of the material through a drying chamber from the inlet end of the chamber to the discharge end thereof, causing a drying gas to travel in the same direction as the material and to pass repeatedly depthwise through the material as the material moves through the chamber, and raising the temperature of the gas repeatedly to increase progressively the temperature of the gas, the wet bulb temperature of the gas being maintained during each passage of the gas through the material below the then melting point of the material, and the gas being at its lowest temperature at the inlet end of the chamber and at its highest temperature at the discharge end of the chamber.

10. Apparatus for drying gelatinous material comprising a drying chamber having an inlet end and a discharge end, an endless foraminous conveyer running longitudinally through said chamber, a plurality of compartments in said chamber

disposed along the length of said conveyer adjacent said conveyer, means for supplying air to the compartment nearest the inlet end of the chamber, heaters for heating air and fans for circulating air mounted in alternate compartments, the walls of said compartments which are adjacent the conveyer only partially closing said compartments whereby air can circulate between the compartments and the part of the chamber containing the conveyer, and means for driving said fans to cause the air to travel longitudinally through the chamber from the inlet end to the discharge end thereof and to pass repeatedly depthwise through the material on the conveyer as the material travels on the conveyer from the inlet end to the discharge end of the chamber, successive heaters being arranged to raise progressively the temperature of the air as the air travels through the chamber, whereby the air is at its lowest temperature at the inlet end of the chamber and at its highest temperature at the discharge end of the chamber.

11. Apparatus for drying gelatinous material comprising a drying chamber having an upper and a lower floor, each floor being provided with a plurality of compartments arranged along its length that are partitioned off from one another, a foraminous belt running the length of each floor, the lower belt running in the opposite direction to the upper belt and at less speed than the upper belt, and being positioned to receive material from the upper belt at the end of the travel of that belt, means for supplying desiccated air of low moisture content to the first compartment on the upper floor, heaters in alternate compartments of the two floors for heating the air, fans in the other compartments of the two floors for forcing the air depthwise through the material as it travels along on the belts, means for directing the air after its repeated passage through the material on the upper down to the lower floor so that it may be reused and passed through the material as it travels on the lower belt.

12. Apparatus for drying gelatinous material comprising a drying chamber having an upper and a lower floor, each floor being provided with a plurality of compartments arranged along its length that are partitioned off from one another, a foraminous belt running the length of each floor, the lower belt running in the opposite direction to the upper belt and at less speed than the upper belt and being positioned to receive material from the upper belt at the end of the travel of the upper belt, heaters in alternate compartments of the two floors, fans in the other compartments of the two floors, means for supplying desiccated air of low moisture content to the first compartment on the upper floor, means for actuating the fans of the upper floor to force the air first through the heaters and then depthwise through the material as it moves along the

length of the upper floor with the upper belt, a shredder at the end of the upper belt into which the material drops off that belt, means for operating the shredder to break up the material before it falls on the lower belt, the next to the last fan on the lower floor being arranged to discharge the air from the drying chamber, and the last fan on the lower floor being arranged to circulate air in a substantially closed system through the material as it travels with the lower belt past the last two compartments.

13. The method of processing gelatinous material which comprises forming liquid gelatinous material into jelled ribbons, depositing the ribbons in a gas-permeable mass on a longitudinally-traveling conveyer, passing air repeatedly through the material depthwise of the material as the material travels longitudinally with the conveyer, and repeatedly raising the temperature of the air after passage through the material and prior to another passage through the material to dry the material, the air being directed to travel between its successive passages through the material in the same direction as the material whereby the air is of lowest temperature when it makes its first passage through the material and is of highest temperature when it makes its last passage through the material.

HENRY E. PECK.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
473,263	Proctor	Apr. 19, 1892
681,229	Kelsey	Aug. 27, 1901
797,276	Glauser	Aug. 15, 1905
1,312,607	Baetz	Aug. 12, 1919
1,547,294	Braemer	July 28, 1925
1,551,818	Garnsey	Sept. 1, 1925
1,744,884	Greiner	Jan. 28, 1930
1,751,552	Kehoe	Mar. 25, 1930
1,813,750	Mackensie	July 7, 1931
1,822,313	Quiggle	Sept. 8, 1931
1,906,694	Lowry	May 2, 1933
1,930,898	Abernethy	Nov. 13, 1934
1,981,806	Lowry	Nov. 20, 1934
2,142,568	Lowry	Jan. 3, 1939
2,216,188	Dons et al.	Oct. 1, 1940
2,280,704	Hurxthal	Apr. 21, 1942
2,339,979	Clarke	Jan. 25, 1944

FOREIGN PATENTS

Number	Country	Date
555,034	Great Britain	July 30, 1943

OTHER REFERENCES

- "Aero-Form Drying," published by Proctor and Schwartz Inc., 25 pages. Received in Div. 49, April 13, 1936 (copy in 34-223).