GLUE

AND

GELATINE

THE APPLICATION AND USES OF MACHINERY, ETC.

COMPLETE LIST OF MANUFACTURERS AND DEALERS IN THE UNITED STATES AND CANADA

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INTRODUCTORY.

FOR some time the publishers of *The National Provisioner* have been importuned by leading members of the glue and gelatine trades to compile in book form the series of articles on the MANUFACTURE OF GLUE AND GELATINE which have appeared in the journal mentioned above. In preparing this valuable work we have not confined ourselves altogether to the articles which have appeared in *The National Provisioner*, and have added much material calculated to make its contents more complete.

The manufacturers of glue have made, and continue to make, special efforts to keep their different manufacturing methods and processes as secret as possible, nearly every gluemaker resting in the belief that his recipes are superior to those of his competitors. Some good reason may exist for all this. When opportunity is given to go through and inspect carefully almost any glue factory, be it large or small, there can be noticed some nice neat arrangement, or some machine or device, or process, enabling economy and good results in one way or another, which might be advantageously copied by other manufacturers. But as a general rule the manufacturer would be much better off if he would allow others to see his factory, and thus in return secure an opportunity to visit other factories.

The articles which appear in this work are from the pens of practical men, acknowledged experts and authorities on the subjects of glue and gelatine, and the encomiums which have been received from the trade are sufficient guarantee of the value of their work.

In presenting this book to the trade and the general public we do not claim that the articles or lists are infallible, but we know that we have used the utmost care and precaution to make them as correct as possible.

For the convenience of scribbling-loving members of the trade, of whom there are not a few, it will be noticed that we have inserted a number of blank pages on which memoranda on glue topics may be jotted down.

We take this opportunity to thank our friends for the large number of advance orders and encouraging letters received prior to publication, and we hope to merit the continuance of the confidence and good-will thereby expressed.

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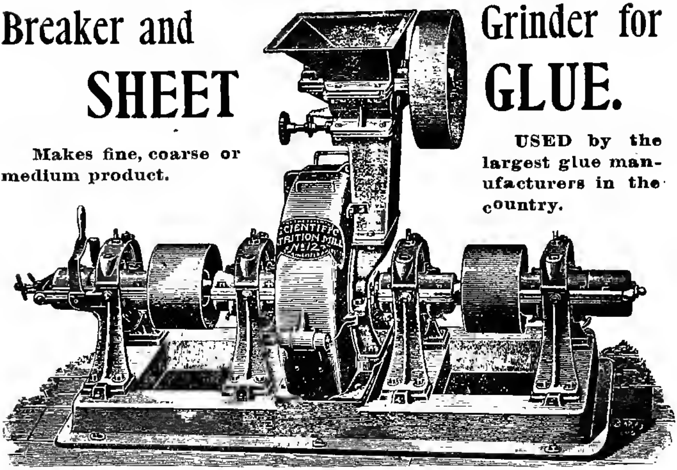

THE MANUFACTURE OF GLUE AND GELATINE.

TABLE OF CONTENTS.

PAGE

THE MANUFACTURE OF GLUE AND GELATINE.......................1-210
Points on Glue Making.......................1
About Glue Stock.......................2
About Liming of Glue Stock.......................9
Glues for Various Purposes.......................13
Waste of Glue Material.......................17
Points About the Water for Glue Factories.......................24
About Coloring Glues.......................31
Clarifying Glues.......................33
Glue in Coolers.......................36
About Drying of Glues.......................41
About Nettings for Drying Glues.......................45
About Bone Glue.......................49
The Cooking of Various Cattle Bones for Glue.......................53
The Leaching of Hard Bones and Horn Piths.......................59
The Temperature for Cooking Glue.......................62
The Bleaching of Glues.......................67
Preservatives for Glue.......................71
About the Foaming of Glue.......................75
How to Make Sweet Glues.......................79
About New Glue Tests.......................83
Recent Improvements and Inventions in the Manufacture of Glues..89
About the Cracking of Glued Joints.......................93
About the Cutting of Glue.......................95
About Hair from Glue Making.......................99
Utilization of By-Products in the Manufacture of Glues.......................103
The Evaporation of Glue in Vacuum Pans.......................109
The Use of Vacuum Pans for the Concentration of Glue Liquor.......................113
About Evaporators.......................117
Glue Tests. (a) Water Tests; (b) Test for "Sweetness;" (c) Shot Test.......................137-148
The Manufacture of Pig's Foot Glue.......................151
The Body Test.......................159
Spandau Test and Other Tests for Adhesive Strength.......................162
Foaming Test of Glue.......................173
About Isinglass.......................179
About Raw Material for Making Gelatine.......................183
Cooking of Gelatine.......................187
How to Economize Acid in Leaching Bones for the Manufacture of Gelatine.......................191
Utilization of By-Products from the Manufacture of Gelatine.......................195
About Dissolving of Glue and Preparing Same for Use.......................199

LIST OF GLUE MANUFACTURERS AND GLUE DEALERS IN THE UNITED STATES AND CANADA.......................213-223

ADVERTISEMENTS.

Blanchard Machine Co.......................III
Dopp, H. Wm. & Son.......................61
Foos Mfg. Co.......................II
Frick Company.......................III
Kahrs, Friman.......................IV
National Provisioner Publishing Co.......................V, VI, VII
Taber Pump Co.......................II
Walburn-Swenson Company.......................I

MANUFACTURE OF GLUE AND GELATINE.*

Points on Glue Making.

The manufacture of glue and the quality of the resulting product is influenced by so many factors that it is of the greatest importance to proceed with every step in the manufacture in the proper manner. Close attention to all the difficult details will alone insure satisfactory results. It is common enough to hear a glue maker complain about the difficulty to produce two consecutive lots of glue of the same quality, though using under the same conditions identically the same material, the same process and the same apparatus for both lots.

It requires no argument that the same causes have the same effects and that the same materials treated in the same manner under the same conditions must result in the same character of product. If, therefore, gluemakers fail to obtain the same products, as they claim, from the same materials under the same conditions, they may be assured that there is something which must account for the difference. There must be some variance somewhere, either in the materials or in the conditions after or during the treatment. Another thing is to recognize these variances, and still another to secure and control material and conditions in the once recognized most suitable form. The average glue maker, if he cannot possibly find the reason for unsatisfactory results, usually being satisfied that he exercised all his skill, is very apt to blame the condition of the atmosphere for his failure

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to produce good results. It cannot be denied that atmospheric conditions have a great influence upon the quality of the glue. The same atmospheric conditions used to have a great influence upon the more or less satisfactory result of our grandmother's weekly washing.

Who among manufacturers and dealers of glue would accept as valid excuse the condition of the atmosphere if your laundryman, be he only John Chinaman, should dare to deliver your laundry in a damp or soot spotted condition; you expect even the Chinaman to be independent of atmospheric condition. Why should the glue maker continue to offer the time worn excuse of unfavorable weather for his mistakes. We recognize that the glue maker's troubles in this respect are not easily overcome. And yet if we see so frequently good material spoiled and the same old "song and dance" performed, we think it's high time that intelligent efforts are made to make the glue manufacturer independent, not only of the weather, but of all those other unfavorable factors, rarely fully recognized as such and still more rarely kept under proper control.

About Glue Stock.

As in every other branch of manufacturing, a thorough knowledge of the raw material is necessary in order to produce good results; so in glue making. The quality and quantity of the glue, grease and fertilizer depend directly upon the quality of the raw material from which these products are to be obtained. Poor raw material will never produce qualitative and quantitative good results. It is therefore of the greatest importance that the glue manufacturer examine carefully his raw material. Such inspection will tell the manufacturer beforehand what results to expect. If the material is poor the manufacturer will have no cause to hunt for any imaginary defects in his

MEMORANDA

MEMORANDA

processes if the glue produced is not quite satisfactory. On the other hand, if the results of working good glue material are not up to standard it is high time for the manufacturer to look for defects in his methods of handling and treating the stock.

Enough reason why the careful manufacturer should begin at the beginning. It requires time and long practice to enable a man to become a good judge of glue stock; however, we want to give a few pointers as to how to test glue material in a practical manner.

Dry stock, not cured, and dry salted stock, such as rawhide or South American stock, offer relatively few difficulties. If a few pieces of such stock are soaked in cold water over night they will gain about 50 per cent. of the original weight, and must offer considerable resistance when attempt is made to cut them; in other words, they must be tough.

The odor of the soaked stock as well as the soak water must be sweet. The amount of moisture, dirt and salt shall not exceed 10 per cent.

In green salted stock, such as hide pieces, sinews, calf heads and pates, we must see that there is no excess of salt; further, no bad smelling pieces, black or blue; none heated—especially during the warm season. This stock must all be of tough nature, the hair must not be loose, the material must have a mild animal odor. The amount of moisture and salt should not exceed 40 per cent.

Pieces of dry limed fleshings and dry limed sheep stock should be soaked in cold water over night; the characteristic odor of limed glue stock should be well developed; among such soaked pieces there should be no smeary, slimy pieces other than saponified fat. In tearing such pieces, which should require considerable effort, the silky fiber of the material should be plainly visible, thus indicating that the raw gelatine has not been injured or destroyed. The water in which such stock has been soaked over night should not be colored dark brown. The percentage of lime, sand and dirt should not run over 5 per cent.

Green limed stock such as sinews, hide pieces, pates, fleshings and sheep stock should be properly limed, which means that the stock should show a smooth, soft surface, that hair and wool be loose, or not present at all. A sharp fork or knife must penetrate the material easily. There should be no excess of lime; the soaking water should not be colored dark brown; the odor should be mild and sweet; the stock must not be heated—especially in summer—and should not give off an ammoniacal odor. Packing house bones should not be overcooked and must have a smooth surface of yellowish color; they should preferably be a little greasy rather than be white and chalky. The latter kind of bones are of no use to the glue maker. The amount of nitrogen in good, hard bones should not be less than equivalent to 5½ per cent. ammonia; chalky bones with a smaller amount of nitrogen have been cooked too much, and the best part of the glue has already been extracted from such bones. The softer bones, i. e., those of the heads, ribs and feet, yield more glue than the hard bones of thighs and legs.

Of bones, as well as of hide pieces, etc., it can safely be stated that those coming from young animals yield more glue and do it more readily than the same materials coming from old animals.

Bones which have been exposed for a long time to atmospheric influences and have become partly putrefied, soft and porous, are of very little or no value for the glue manufacturer.

Horn piths should not contain over 12 per cent.

moisture, and should not show any brown spots; if they contain more moisture they are insufficiently dried, and the purchaser pays for an excessive amount of moisture; brown spots are a sure indication that the piths were dried on hot coils, and that the gelatine has been partly decomposed and destroyed.

Skin and hair on the piths are of little value to the glue maker, and, therefore, not wanted by him. The tips of the piths should not be brittle. If they are easily broken off the piths have been overcooked.

The above suggestions, while not giving complete advice regarding the desirable condition of all kinds of glue stock, will suffice to enable a careful buyer to protect himself. They will tell whether stock has been carefully and properly prepared, or whether such care was lacking, or the desire of putting the stock with excess weight on the market was prevalent in preparing the stock.

We want to call the attention to one more point regarding limed fleshings which is of considerable importance. The tanners in their desire to shorten the time of preparing their hide material for the tan vats have gradually been replacing partly or entirely the treatment of their hides with lime; the material mostly used for this purpose is sulphide of sodium. Such stock, while it may be partly limed, and even appear as properly limed—from a gluemaker's point of view—requires special treatment to insure satisfactory results. Such stock will often show a greenish or bluish color. In the hands of an expert such stock will readily reveal its nature. We advise gluemakers to look out for such fleshings, and eventually to consult an expert. But to all gluemakers we recommend: Examine your stock carefully before starting to work it; the time expended will save many disappointments.

MEMORANDA

About Liming of Glue Stock.

The liming process is the most important part in the preparation of glue stock and seldom receives the attention it deserves. Empirical rules usually govern this process. If the results are good, all right; if not, it's all wrong, but frequently not discovered until the glue is finished and defective. It would appear almost indispensable that the glue manufacturer should have a thorough knowledge of the material used for this process, and yet how seldom is an analysis made of the lime as to its fitness for glue-making. Even the quantity of lime used is no serious object of consideration as long as fairly good results are obtained. The factory foreman is usually contented with the knowledge that the lime slacks well. The fact is that the oxide of calcium is the only valuable component for our purpose; all others, magnesia, salicon, carbonate of lime and magnesia, alumina and iron compounds, stones, are only useless if not detrimental fillers.

The object of the lime is to dissolve the gummy brown substance of the glue stock, to loosen the fiber, to cause the latter to swell by water absorbtion to, occasionally, almost double its original weight, thus to make the fiber more soluble in hot water; the oxide of calcium must further act upon the fat and transform same into an insoluble soap; it must furthermore loosen the hair by dissolving the hair bulb (wool included) and give to the stock a lighter color, and act at the same time as a preservative for keeping the glue stock sweet for some time.

It is therefore most desirable to have occasionally a complete analysis made of the lime used, to ascertain whether such lime is suitable for glue-making and maintaining its qualities. The great variety of limes produced in the United States fully justifies such precaution; the percentage of calcium oxide in such limes varies between 50 and 95 per cent.

But it is not only the quality of lime that determines the results—as a matter of fact, even the poorest lime, used with the proper care, can give good results, and the best lime used without proper consideration of its object will give disappointing results. It must be remembered that the lime can only do its work when all parts of the glue stock come in contact with sufficient quantities of lime, and furthermore that the necessary quantity of water be present to serve as a vehicle for the lime and to give the fiber an opportunity to absorb sufficient of this water to assume the swelled appearance, so essential for quick action of the boiling water later to be applied.

We have seen liming vats so piled up with almost dry stock that there was absolutely no room for the required amount of lime and water; three tons of glue stock being piled in a vat which properly should not be taxed with more than two tons. The stock put through another liming disclosed readily plenty of black and blue marks and a very strong smell of ammonia. These colored spots and the ammonia both indicate the same thing, viz.: loss of valuable hide material and partial decomposition. Every pound of ammonia escaping is equivalent to a loss of 20 pounds of glue stock. Furthermore it may almost safely be relied upon that limed stock showing these defects will not produce a glue free of strong odor or of strength equal to that of glue prepared from same stock if properly limed.

Again we have seen stock plastered up with dry lime paste and full of small stones; the lime used being not properly slacked, a poor quality of lime used, and the stones not screened out of the milk of the lime. The amount of trouble caused by these small stones is fairly well known. They require a great deal of acid, cannot be washed out readily, sticking solid in the hair or wool;

MEMORANDA

MEMORANDA

most of these lime stones go with the stock in the boiling vats, cause the glue liquor to turn dark, besides saponifying fat and cutting the strength of the glue.

To avoid all these troubles it is only necessary:

(1) To use none but the best grades of lime.

(2) To screen the lime milk.

(3) To stir the stock frequently during the liming process or better still to use rotary vessels wherein stock and milk are kept in constant motion.

(4) To use a weak lime milk for the first liming and a stronger milk for the second and eventually third liming.

(5) Not to crowd the vats.

Glues for Various Purposes.

Why is it that one grade of glue does not answer for all purposes? This question has often been asked. It seemed to puzzle especially some of our packers who started, or intended to start, in the glue business. Their desire was to run a glue factory on packing house principles. It required time for them to learn that there are some good reasons why glue factories have a season when they almost shut down, and that this season should be at the time when the beef killing and the production of glue stock thereof are usually larger than at any other time of the year. The large variety in the qualities of glue did not suit our packer-gluemakers at all.

Said one of them: "Why should it not be possible to run a glue factory just like a packing house? I have 1,000 barrels of green hams piled up, and make a sale of five carloads of them to be shipped at once. The hams are loaded at once; no selection whatever is made. Why can't I handle the glue in similar manner?"

However, our packers have learned something about the glue business in the meanwhile, and while they may be still desirous of running their glue factories more on packing house principles, and have introduced methods to accomplish their end to a certain extent, they recognize that it is impossible to make a uniform grade of glue suitable for all purposes.

The different consumers of glue call for different articles with different qualities, and accordingly are willing to pay between 6c. and 40c. for a pound of glue answering their purpose.

Let us look at some of the demands made on the glue by the different consumers:

The cabinet maker calls for the best grade of hide glue. To meet his requirements the article must have a great body, must be light in color, must not dry very fast, and not too slow, either.

The furniture man wants a glue of a very high test; it must make a satisfactory joint on two pieces of maple wood. His glue must be sweet, and should not turn dark over night. The glue shall not foam if applied for veneers with revolving brushes.

In sewing machine factories, as well as in carshops, where veneering forms one of the most important parts of the work, we have heard the foreman say: "I cannot use such glue; it foams too bad. Veneers glued with such stuff do not stick; they split off; and if they do not come off altogether, they will at least show a rough surface, full of air bubbles."

The wall-paper man does not care so much for a very high grade glue. Glue of less body and strength will answer for his purpose, as long as the glue is free of grease.

Paper makers are very fond of German Cologne glues and imitations thereof.

Match factories have a decided preference for Irish glues; they mix readily with the phosphorus and stick well to the wood.

Paper box makers want a low grade glue, colored a little, drying slowly and being free of any strong smell. The girls handling the paper prepared with glue having an obnoxious odor, object to the latter, and may cause a great deal of trouble to the gluemaker. Glue applied on colored paper should not discolor same.

The manufacturers of straw hats want the best grade of hide glue; it must be of light color and withstand the test with oxalic acid.

Confectioners want nature-white gelatine; free of animal smell; it must go very far in making jellies.

We could mention a number of other trades giving preference to some special glue, but it would be difficult to publish a complete list. Although the market is usually flooded with many kinds of glue, they don't answer for all purposes, and it is frequently necessary to make compositions of glue with other materials.

For printer's rollers glue is mixed with glycerine; for stationer's glue, with glycerine and sugar. The so-called waterproof glue consists of glue and carbonate of lime, or glue, zinc white and alcohol. Glue for preparing ties is a mixture of glue, "stick" and sulphate of zinc.

It is frequently a very difficult matter to tell which grade of glue will suit a new customer. A sample of glue may be very closely matched, and yet there may be minute differences which will make one grade of glue acceptable to a customer and the other entirely unsuitable. And again, identically the same glue may give excellent satisfaction for a certain class of work with one customer, and prove to be very unsatisfactory for the same work with another customer, due often to extremely small differences in the manner of applying the glue. It takes years of experience to become a good judge of glues.

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Waste of Glue Material.

As a rule, the results in testing the glue raw material do not correspond with the actual practical results. Instead of attempting to conform the latter with the test results, tests are abandoned, and thereby the one basis which would enable a glue manufacturer to obtain a control over his manufacturing process. Occasionally tests are made, but if the practical results do not come up to expectations there is always an excuse ready to cover defects; the difficulty in sampling the stock or in keeping the different runs of glue apart usually furnishes the excuse; then again there is not enough fat to make it worth while to spend any labor on its separation. It's the same old story: excuses are easier found than chances for excuses avoided. We admit the difficulty in making satisfactory tests of the yield of different glue stock, but we are fully convinced, and our experience justifies the belief, that glue tests can be made on a good sound basis, and furthermore, that such tests are not a mere waste of time and effort, but form the best instruction for a progressive, careful manufacturer; the labor expended on them, if done properly, is well repaid.

It is astonishing how little attention is paid to the losses of glue stock, fat, and even glue, not in some, but in most, glue factories.

We will point out a few of the biggest leaks through which glue material finds an escape. The first loss is in the liming process, especially in summer time, when warm milk of lime is used. A strong smell of ammonia is a sure indication of a loss of glue. If the very safe rule, that one pound of ammonia produced is equivalent to a loss of 20 to 24 pounds of green salted glue stock, is kept in mind, the necessity of looking closely after this department will readily be seen, especially as it seems to be customary to

MEMORANDA

let old invalids and pensioners attend to this work of liming the glue stock.

Careless liming will also produce a fat running high in free fatty acids, which means for each 13 per cent. of free fatty acids a loss of 1 per cent. of grease on account of the loss of glycerine liberated from the fat and removed with the lime water. The gluemaker's loss is not by any means the soapmaker's gain; with prices for crude glycerine at 5 and 6 cents per pound, and with most soapmakers striving or preparing to recover all the glycerine from the fat, the time, we hope, is not very far off when the soapmakers will insist on and be ready to pay for fats almost devoid of free fatty acids. The safest way to prevent loss of fat is to trim the stock carefully of all the fatty tissue, and to render such trimmings separately.

The most rational way to prepare and use the milk of lime is to have the milk of lime in large quantities in roomy vats placed on a higher story than the liming vats proper, the milk of lime to be drawn from such storage vats as needed, these vats to be provided with agitators of some kind to keep the milk of lime in motion, and the particles of lime in uniform suspension. This method of working means a great saving of lime, because every particle of lime can be used to its full strength. In preparing a larger quantity of milk of lime, and not using same freshly made, we also gain the important point that the grease is not so easily saponified as by lately slaked lime.

The next loss of glue material is in washing the limed stock. The great quantities of water used for this purpose will carry away small pieces of glue stock and green fat. If catch-basins or other contrivances are not provided sufficiently large to allow fat, glue stock, hair and lime to separate from the water, a dead loss is not avoid-

MEMORANDA

able in this washing process. Frequent cleaning of these catch-basins is naturally a necessity.

Another loss is caused by the action of acid upon limed stock; the oleic (fatty) acid produced is carried off and must be collected in catch-basins. Careless use of acid will allow a great deal of raw gelatine to be dissolved in the acidulated water to be carried off beyond recovery; this is especially noticed on horse fleshings.

Some manufacturers claim a loss of material in cooking the glue stock, insisting that part of it will escape in gas or vapor form. When the stock has been properly prepared, such claims are absolutely groundless, and must appear ridiculous to any one really acquainted with the nature of glue. These claims furnish, however, one of those convenient excuses referred to above, for unsatisfactory yields. We know of losses of glue in cooking only when the stock has not been properly washed, when the lime present will decompose the glue into ammonia and "stick," and when leaky cookers and valves will allow the glue liquor to run in other directions than its intended destination.

In the process of clarifying the glue liquor the loss is very small, provided vats and valves are tight. Greater are the losses in concentrating glue liquors in evaporators of all kinds, if such evaporators are not properly attended, or constructed on wrong principles. We had occasion to find in the "condense water" of vacuum pans from one-hundredth to one-quarter per cent. dry glue. When we remember that for each gallon of glue liquor evaporated about 25 to 30 gallons of "condense water" are produced, we can readily see how big the waste of glue during the process of evaporation may be. Most of the Western gluemakers are probably familiar with that one instance where an unsuccessful manufacturer attributed his failure

MEMORANDA

to the evaporator, claiming that this machine had sent all his profits in the canal. In later years another case of an extremely wasteful evaporator came within our observation, where it was difficult to decide whether the apparatus or its condition, or the operator was to be blamed for the results. One thing is certain, evaporators offer great advantages in the manufacture of glue, but such evaporators should be built on certain principles to avoid a qualitative or quantitative deterioration of the glue.

The tank refuse, especially in winter time, contains frequently a good deal of raw stock, not properly cooked, due probably to the crowded, rushed work. And again, it is not only on rare occasions when glue jelly can be seen spattered over the floor, especially where the hair was thrown out of the cookers; the cause of a small loss only, but just the same representing perhaps the odd penny. Another loss of this kind is caused by leaky coolers, and also by the customary method of washing the emptied coolers before being refilled. Nearly every glue factory contains but one vat filled with hot water for cleaning the coolers. A better plan is to have two such vats; the coolers to be cleaned in the first one from the bulk of the adhering glue, and in the second one to be made perfectly clean and "sweet." Some preservative, as sulphate of zinc or carbolic acid, may advantageously be dissolved in the water of the second vat. The water from the first vat should be used for dissolving the floor scrapings and for cleaning the nettings, and then be returned to the receiving vat.

In dissolving bones in acid, we would advise to screen out the fine bone meal, which is otherwise a dead loss, besides costing handling and acid.

Many other causes for losses of material and glue could be mentioned; we have only picked out some of the most common ones. If the manufacturer will hunt up all these little chances for waste, he will find a remedy for them, will find his yield tests more satisfactory, and finally in them a direct control over his manufacturing process and a reliable guide through it.

Points About the Water for Glue Factories.

The water supply is of the greatest importance for a glue factory; like in a great many other manufacturing branches depending more or less upon chemical reactions, the available water supply determines in a large measure the character of the product of a glue factory. And yet how little attention is paid to this point. How many gluemakers went to the trouble and expense of having the available water analyzed when selecting the location of a new glue factory? The gluemaker knows that he must have a large supply of water, and as long as this is in view the quality of the water receives little or no consideration. Troubles may later on arise in a glue factory, and perhaps the gluemaker may consult a chemist, occasionally with satisfactory results, oftener without getting adequate return for his money. It is not sufficient to be a good chemist to render valuable service in such a case, it is just as necessary to have a practical knowledge of the manufacture of glue. The most accurate and complete water analysis is of little or no value when the ability is lacking to interpret the results—in the hands of a scientifically trained and practically experienced man an accurate water analysis will often furnish the explanation for numerous troublesome occurrences, and will also show the remedy to overcome same. We repeat, the water question is of greatest importance in the manipulation of glue; both the quality and quantity of the water supply must be satisfactory to secure good results.

MEMORANDA

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We need hardly mention the necessary requirements of the water for boiler feed purposes. A manufacturer must be a back number, indeed, who does not know that hard water is not suitable for this purpose; it may be less generally known how great the influence of "scale" is upon the efficiency of a boiler. A sixteenth of an inch thickness of hard "scale" on the heating surface of a boiler will cause a waste of nearly one-eighth of its efficiency, and that the waste increases as the square of its thickness; thus, hard scale of an eighth of an inch will cause a waste of nearly 50 per cent. But our intention is not to speak of the desirable qualities of feed water in general, but of its objectionable qualities in glue factories. As the cooking of the glue stock is done with steam coming from the boilers directly, or as exhaust steam, the feed water should not contain any volatile compounds injurious to the glue stock in the cookers, such as sulphur in the form of sulphuretted hydrogen, or of free sulphuric acid, ammonia and volatile products of organic decomposition. So much regarding boiler feed water.

For liming purposes almost any kind of water can be used, as long as it is free from smell and sulphur, and, of course, free from putrefaction. But even if the water is not quite fresh, it could be used, if necessary, provided the milk of lime is frequently renewed. Hard water is not so objectionable in liming as wasteful in preparing the milk of lime. The temperature of the water used for liming should not exceed 80° F.

For washing limed stock the water should again be free of smell and sulphur, but, furthermore, the water should be soft, at least the "temporary hardness" of the water should be as low as possible. The hardness of the water is due to two different causes; sulphate of lime produces "permanent hardness;" boiling or treating with slaked lime does not affect this hardness, hence its qualification as permanent. This permanent hardness is not directly disadvantageous for washing limed stock. The temporary hardness of water is due to bicarbonates of calcium and magnesium. These bicarbonates are soluble in water of ordinary temperature; heating will decompose the bicarbonates into carbonic acid, which escapes from the water, and into mono-carbonates of calcium and magnesium, which are insoluble in water, and hence precipitate. Water of "temporary hardness" loses, therefore, the components causing this hardness when being heated, which explains the term. Water of temporary hardness coming in contact with calcium hydroxide (slaked lime), undergoes a similar change; the bicarbonates give off half of their carbonic acid to the calcium hydroxide, becoming reduced to insoluble mono-carbonate and transforming the calcium hydroxide to the same insoluble substance. If glue stock containing calcium hydroxide permeated through its mass is washed with "temporary" hard water, it is evident that the soluble calcium hydroxide is rendered insoluble, precipitated and fixed upon the fiber of the glue stock in a similar manner as dye stuffs are fixed upon woolen or cotton fiber by mordaunts. This explains why such hard water will "paste up" the glue stock, and make the washing process very difficult, and also why the preparation of milk of lime with such water is wasteful. If a glue factory is, however, compelled to use such hard water for washing the limed stock, several methods are possible to render the water more suitable for the purpose; acidulating will produce the quickest results, but where this process is not desirable other ones can be found suitable to the local conditions.

The temperature of the wash water may be slightly raised; 80° F. is certainly not too high. We know of concerns who use successfully the waste water off the vacuum pan, with a temperature of 90 to 98° F., for washing purposes.

For cooking glue stock only soft water can be used to advantage, being free of salt, iron, sulphur and ammonia; this water must naturally be odorless. These requirements are especially necessary for making gelatine or finest grades of hide glues.

For washing coolers and nettings soft water is desirable, as these washings are to return to the cookers.

Some of the bad effects of unsuitable water noticeable on the finished product are as follows: (1) On fine grade of hide glues the appearance is spoiled; the glue looks somewhat milky, especially when sulphurous acid has been used; the same defect, only more pronounced, is noticed on sinew and pigsfoot glues. (2) Colored glues failed to show the nice bluish-white color; were more of a dead white or yellowish-white, showing a very rough surface. (3) The strength of the glue, especially of fine grades, can be reduced as much as 5 per cent. (4) The glues form a sediment after standing dissolved in a warm place for a short time, and give a great deal of trouble in getting uniform results in glueing.

Gelatine for culinary or photographing purposes must be prepared with distilled water.

Is it worth while to pay more attention to the quality of the water supply?

MEMORANDA

About Coloring Glue.

The natural color of glue varies, from almost colorless to yellow and light and dark brown, according to the quality of the raw material and the curing and working of the same. The coloring of gelatines is done exclusively with aniline colors. High grade glues showing a light yellow color, which is often objected to, are occasionally colored with an aniline blue to neutralize the yellow tint. Glues colored in such manner are apt to have a greenish color; if the shade and quantity of blue are properly selected, the yellow color may be neutralized without developing a greenish tint.

Russian glues are colored with carbonate of lime, and sometimes even with sulphates of barytes. The weight of these substances amounts occasionally to 25 and even 30 per cent. of the glue. It is claimed that the presence of these materials in the Russian glue increases the strength of the glue to a certain extent. It is true this additional weight is advantageous to the producer, and it is said authoritatively that this filling renders the glue more adhesive for cabinet work. Nevertheless, Russian glues are well liked.

Very little colored glue is made in other European countries. In the United States a great many consumers use nothing but colored glues. The coloring done in the United States is principally done with zinc white, of which two kinds are used, the French green seal and the domestic zinc white. The price of the domestic article is considerably lower than that of the French product; the domestic product can, however, be recommended only for use on low grade glues. For fine grades of glue the French zinc white has not been surpassed; it has a great covering power, is a good deal finer than the domestic article, and therefore does not form a sediment in glue jellies as readily as this one. Furthermore, the French product is of pure white color; the domestic one shows a slightly yellow shade; two parts of French zinc white have about the same coloring effect as three parts of the domestic.

Glues colored with zinc white have a very nice appearance; the brown color of the glue is well covered. These glues find a more general use than the clear, dark brown glues; one of their great advantages is the fact that zinc colored glues do not turn sour, even if the jelly prepared from them is allowed to stand around several days in a warm room. The one drawback of colored glues is their tendency to foam when applied with revolving brushes.

Clarifying Glues.

The value of a glue liquor and its adhesive power is not materially influenced by small quantities of undissolved suspended matter. For Russian glues an increase of the "strength" is claimed for the addition of zinc white. The cloudy, murky appearance of a glue liquor may, however, be an indication that the glue is partly decomposed and spoiled. For this and other reasons the manufacturers endeavor to get their glue liquors as clear as possible.

If glue liquor is produced from sound stock, properly cured, and if every precaution is taken to insure a good product, we can see the liquor coming clear from the cookers. It is only necessary to collect such liquor in a large, relatively shallow vat, to allow grease and impurities to separate from the liquor.

After a few hours' settling, samples are taken from top and bottom of this vat, and if the liquor is sufficiently clear, it is run off and turned into glue jelly. There is very little trouble with the first runs; the gluemakers say they take care of themselves. These first runs aregenerally clear without further treatment. The last runs are different; they are always muddy, and require some treatment if clear glues are to be produced. Frequently the last runs are not worked up into clear glues, but are rather colored with zinc white, thus producing a good looking, salable glue without requiring clarification.

If glue liquors are to be clarified by merely allowing the glue liquor to settle and deposit any suspended matter, one factor is of the greatest influence: the concentration of these liquors. The weaker a solution is, the quicker—as a rule—will the suspended matter settle. This is one of the principal reasons why evaporated glues can more easily be obtained free of sediment, and also free of fat. The weak and not yet concentrated liquors offer less resistance to the settling of any sediment as well as to the rising and separation of fat.

The clarification of glues alters the strength to some extent, whether it is accomplished at a lower or higher temperature. It is a well and long known fact that one of the principal conditions for successful clarification is that the stock be well cured, and that the glue be not "doctored." If glue stock or glue liquor has been treated with sulphurous acid, it is sometimes only necessary to add some old milk of lime to it, and to stir up the bulk of the liquor to distribute the lime evenly through it, when the glue starts to curdle and a heavy sediment begins to form, leaving the supernatant glue liquor clear after a short time. The glue liquor must still show an acid reaction after the treatment with lime, otherwise the liquor will not get clear. Glues with little or no acid reaction are better clarified with alum or albumen.

Instead of alum, there may advantageously be used sulphate of alumina; pure liquid blood, fresh from the cattle, may replace the albumen; the substitutes named are cheaper and give better results. Neutral or alkaline liquors will clarify with alum (or its substitute) alone, or with the addition of a small amount of milk of lime. By heating the liquor to the boiling point the impurities rise to the top of the liquor, and fall to the bottom when the steam is shut off. Three or four hours' settling will produce a clear glue liquor.

The clarification with albumen or blood is somewhat different; the liquor must be cooled down to 130° or 140° F. before the albumen or blood is added. After thoroughly mixing the liquor it is heated at 210° F., which will cause the albumen to coagulate, thereby mechanically enclosing and carrying with it all the impurities. The settling does not take place as rapidly as when alum is used, requiring twelve to twenty-four hours. This is due to the spongy nature of the coagulated albumen. Glues clarified with albumen have usually a characteristic smell, and show a tendency to foam. Of late years attempts have been made to use other materials for clarification; very little is known about results. For the present the clarification methods using milk of lime or alum or albumen are the only successful ones, carried out on a large scale.

Glue in Coolers.

When the glue liquor reaches the desired degree of concentration, either by longer continued cooking in the kettle or by evaporation in a vacuum pan or a "multiple effect" evaporator, it must be converted into a firm jelly before the further drying of the glue liquor can be successfully carried out. The strong glue liquor is liable to turn sour in a very short time, especially where the hot liquor is cooled slowly, as apt to happen in summer time. The most dangerous temperature for the souring of the glue is near blood heat, or at and about 100° F. Above 150° and below 65° F. the liability of souring is much less than between 120° F. and 80° F. The souring of the glue, like every other process of putrefaction and fermentation, is due to the development and propagation of infinitely small germs which thrive best at the temperature stated, between 80° and 120° F. These germs exist almost everywhere in the atmosphere, and from it find their way in the glue liquor, where, under favorable conditions, they develop very rapidly. It is, therefore, very important that the time of existence of these favorable conditions be reduced as much as possible, or, in other words, to leave the glue liquor exposed only the shortest possible time to the dangerous temperatures. The glue liquor must, therefore, be cooled as quickly as possible.

Different methods of accomplishing this object are in use. The glue liquor is usually allowed to run into the so-called coolers, boxes whose size and form vary in different glue factories, some preferring a long and shallow box to an almost square and deeper box, narrower at the bottom than on the top, these boxes holding about 50 lb. glue liquor. Wooden zinc-lined boxes are gradually giving place to boxes built of sheet zinc or of heavily galvanized sheet iron. The all metal coolers have the decided advantage of being built of a good conductor of heat, thereby enabling the quicker chilling of the glue liquor. The deeper boxes (11 to 12 inches deep) permit a better settling and separation of the impurities from the glue; the long, flat coolers permit more rapid chilling. Coolers built of strong sheet zinc are perhaps the most economical, as they last long, do not rust, and thereby discolor the glue.

The coolers filled with the glue liquor till within one-half inch from the top are set in an airy, well-ventilated room, protected from summer heat and winter cold (to prevent freezing of the glue). The coolers are set level on a rack, a few inches above the floor and about two inches apart to allow free circulation of the air, thereby accelerating the cooling process. Leaky coolers are marked and repaired before being used again. Other factories place the coolers in a slow current of water, which works very well when the water is cool enough, but only few factories have a supply of water sufficiently cold for the purpose, especially during the summer months.

In some European factories, perhaps also in one or two of the American factories, the glue liquor is poured on glass tables in a layer of about one-quarter inch thickness, the under side of the glass plate being cooled by running water. For the manufacture of glue on a large scale this process is hardly practicable. When open air cooling is utilized, the gluemaker is exposed to all the uncontrollable influences of the weather, which permit of no proper regulation and system in the manufacture of glue. Gluemakers have, therefore, tried to make themselves independent of atmospheric conditions. They build ice houses holding several hundred tons of ice, and use this store of cold to transfer their glue liquors into a firm jelly. But ice houses are rarely clean places, especially those for glue chilling, where glue, slime and water are apt to collect on the floor. Furthermore, the stocking of such ice houses with ice is quite costly, usually necessitating the shutting down of the glue factory during the icing period, especially when a good deal of glue is to be manufactured during the warm season. Ice machines have, therefore, been introduced to replace the natural ice supply. The chilling rooms are then cooled systematically with cold brine circulating through pipes placed near the ceilings of the cooling rooms. Such cooling places usually have the inconvenience of lacking fresh air circulation. As the hot liquor runs into the coolers the air becomes saturated with steam, which vapor-loaded air should leave the cooling room before the chilling is commenced. Sometimes opening of two opposite doors will create a sufficient draught to remove the steam. But far better is the use of a blower, running it long enough till all steam is dispersed and the glue liquor has started a skin; then is the time to let the brine pump work; the temperature shall not fall below 33° to 34° F., as frozen glue jelly is brittle and cannot be cut. These cooling houses should be scrupulously clean and sweet; reliable thermometers shall hang at different places and within easy reach.

Under no circumstances should the brine pipes run on the walls; only on the ceiling; never on the floor. If the pipes are heavily coated with ice they must be freed from it either by melting or chopping it off; the steam of hot glue liquor does it best, if aided by a blower. Properly constructed cooling houses, if kept clean and "sweet," will never turn out sour glue.

For a long time the ideal and much desired process has been to chill, set, cut and eventually even dry the glue in one operation. Mr. E. Hewitt, of Peter Cooper's glue factory, claims to have solved this problem. The glue is chilled on a revolving cylinder cooled by circulating cold water or brine. This horizontal cylinder revolves slowly, dips with the lower portion into the glue liquor, carrying enough of the latter on the surface to form when chilled (in less than one revolution) a thin layer of firm jelly, which can be wound off the cylinder as an endless ribbon, cut by the machine in suitable sections, spread on frames and forwarded to the drying rooms. The apparatus and process is patented in different countries; its principle is a very promising one. Mr. Baeder, of Baeder, Adamson & Co., of Philadelphia, some years ago experimented with a machine on the same principle; he attributed his failure to make the machine work successfully to a peculiar circumstance. He claims that he found it impossible to find an endless belt, apron, roller or other device, in spite of a great many materials tried, which would take or carry the jelly ribbon off the chilling roll without robbing the contact surface of the glue of the brilliant, shining appearance which the trade demands. It is possible that the trade may modify its views on this point; it is not impossible that Mr. Hewitt succeeded in overcoming the difficulty.

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About Drying of Glue.

The final and probably the most difficult process in the manufacture of glue is the drying of the product. Open air drying has long ago been abandoned, and glue is to-day exclusively dried with air currents produced by mechanical appliances, and thereby under the control of the manufacturer. The glue jelly, cut in suitable sheets, is spread on the netting frames. These are piled up in stacks on a carriage, and the latter placed on a track, which runs through the alley in which the drying is to be done. This track consists of small-sized rails at a fall of 1 foot to each 100 feet in length. These alleys are 6 feet wide by 6 feet high, or 8 feet wide by 8 feet high, and as long as 250 feet. The top, sides and bottom of the alley are covered with flooring, so as to make them as independent as possible from atmospheric changes, to prevent moisture to accumulate in winter and to prevent excessive heat in summer. Walls built of brick or stone are not suitable for drying alleys. The temperatures of the air current to be used for drying must be between 60° and 90° F., according to the quality of the glues and the kind of the weather. As this temperature is a very dangerous one for the glue, great care has to be used to prevent the glue from getting dark and turning sour. Some glue is almost as difficult to dry as the so-called "stick." Great care is required to have every lot of glue dry out in good condition. The glue on the netting must be watched day and night; also the temperature of the air passing through the alleys. If the temperature is too high and the air moist the glue will be soft and will run through the nettings, which happens most frequently on hot and stormy days. If the temperature is too low and the air moist, the glue will not dry, and will acquire a blind surface; may become full of holes and smell extremely offensive after being dissolved, showing very poor quality all around. If the temperature is too high and the air dry, the glue will dry too fast, will become full of air holes, and if left in the alley too long this glue will become extremely brittle and will show up cracked. If such a glue is run through a crusher it will turn out as a coarse powder. In Europe, where the glue is very often turned on the nettings, cold and slow drying is used. The glue sheets turn out straight, of a smooth surface and free of air bubbles. In Europe it is not customary to crush dry glue. In the United States glue is dried by a high temperature, air bubbles are not very objectionable, as a great deal of the glue is crushed before it leaves the factory, and only a small quantity is shipped in sheets. A great many experiments have been made to make the glue drying process a safer and more satisfactory one.

With some success sulphurous acid and chlorine gas have been blown, mixed with the air, through alleys to prevent the souring of the glue. On stormy days ice machines have been used to free the air of a larger portion of its moisture before forcing it through the glue alleys. The safest way, however, is not to attempt to dry glue on rainy or extremely hot days. It is of great importance to have the netting in good condition to concentrate the glue heavily before cooling it, and to cut the jelly in thin sheets; and last, but not least, to use plenty of air, or, which amounts to the same, to have plenty of blowing capacity wherewith to furnish a strong current of air.

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About Nettings for Drying Glues.

In European glue factories generally, and occasionally also in American factories, cotton nets are used for spreading and drying the glue. These cotton nets have advantages, but also such decided drawbacks that in the United States wire nettings have mostly replaced them. It is known how these wire nets are stretched on wooden frames, constructed in a manner to keep the different nets at a certain distance and to insure a staple stand, when piled up; the object, of course, being to give the air free access to the glue slices, thus hastening the drying process and preventing the formation of sour glue.

These nettings are made of elastic wire, so-called galvanized wire, coated with zinc to prevent rusting of the wire. Almost every glue factory has considerable trouble with these wire nettings. The general complaint is that after a few weeks' use the zinc has all been eaten off, and that the wires are rusting rapidly, making it impossible to spread white glues on them without seriously damaging such. After a little while the nettings begin to "hang down," touch each other, making quick drying impossible and sour glues probable. With the zinc and exposure to continued rusting the wire loses its entire elasticity.

The reason for such complaints or the phenomena occasioning them is very simple. The zinc coating on such wires is not sufficiently heavy; the zinc furthermore not pure enough, dirty and full of air bubbles. Such zinc will naturally oxidize in a short time, forming oxide of zinc, which adheres readily to the glue, and in quick order the entire amount of zinc will be worn off, leaving the iron wire behind. This rusts very easily, imparting the rust to the glue and giving it an ugly reddish color. Finally, these wire nettings have to be thrown on the scrap-pile.

Almost every glue factory is decorated with these discarded nettings. All the troubles and expense of such poor nettings can be overcome by securing nettings coated with sufficient zinc and of a quality to withstand the rapid corrosion. The percentage of zinc on such wire (on the straight pieces, exclusive of joints or knots) should be above 15 per cent., better near 25 per cent., and should be ascertained by chemical analysis. Furthermore, the zinc coating should be carefully examined under the microscope, and should be found smooth, free of dirt and grit and air bubbles. Good nettings should last for over two years.

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About Bone Glue.

Immense quantities of bone are used for the manufacture of glue in the United States. The quality of glue produced from this material varies from the best gelatine down to "stick," depending upon the quality of the bones as well as upon the care in treating and curing them. There are two radically different ways of manufacturing bones into glue. One is to convert the green bones direct into fat, glue and bone meal. The other to prepare the green bones for the manufacture of glue by the so-called leaching process.

A great many different methods are in use to convert green bones directly into glue, fat and bone meal, all of which can, however, be classified among one of the four following:

First—Cooking in open vats and making as many runs of glue liquor as necessary to accomplish the extraction of grease and glue as completely as practically possible. In carrying out this system it will soon be observed that the liquors are getting weaker and poorer from run to run, and there is a limit to the number of runs, as the glue liquor is getting so diluted that it will not pay the cost of evaporating these weak runs. Glues produced in this manner have a fair appearance, especially if the stock was washed and crushed. The first runs are fully equal to the last runs of hide stock. These glues are easy to clarify, but they possess a very strong animal smell, so-called bullock smell, which makes them unsuitable for certain purposes. These glues can, however, be produced much better in quality, odor and color if the stock has previously been bleached with sulphurous acid. If this bleaching is done carefully, hardly any effect can be observed on the fats and oils produced from bleached stock, except that they are somewhat lighter in color.

The bone meal obtained from cooking the stock in open vats, after being dried, is of a nice grayish white color, and analysis shows same to contain 3 to 4 per cent. ammonia and 50 to 60 per cent. bone phosphate. The quality of this bone meal is between steam bone and raw bone.

Second—Cooking in tanks under a pressure of about 10 to 15 pounds with an addition of water. In this method usually two runs are made, each of two to three hours' duration. The glue liquor obtained is drawn off from the tank after the steam pressure has been reduced. The glues obtained in this manner do not show very much different from those obtained by cooking in open vats, provided sufficient water and not too high a pressure has been used. Generally the liquors obtained in this manner are more concentrated than those obtained by open air cooking, and therefore require less evaporation. They do not have a strong bullock smell, but if carelessly produced these glues are of a dark color and sticky nature. While open vat cooking produces about 5 to 10 per cent. glue, the yield in cooking under pressure is 10 to 13 per cent. of the bones employed. The bone meal produced by this process is soft, of a nice white color, shows 2 to 2½ per cent. ammonia, often less, and 60 to 70 per cent. bone phosphate.

Third—Cooking green bones under low pressure, adding no water at all or only a small quantity. The glue liquor produced (extracted from the bones by the condensed steam) is run off constantly as fast as produced. This so-called English process produces glues of a very good quality, which do not require very much treatment, on account of their sweet and clear nature. The bone meal produced is about the same as the steam bone produced by cooking in closed tanks.

Fourth—Cooking green bones under pressure of about

20 pounds in revolving tanks with no addition of water for about three or four hours. The condensed water (glue liquor) is drawn off constantly as soon as produced. After three to four hours' cooking the bones are taken out, coarsely crushed, and are recooked into glue, fat and bone meal in open vats. The glues produced by this so-called French process are of the best quality, very sweet, and can compete with any fleshing glue. The bone meal shows about 2 to 3 per cent. ammonia and 50 to 55 per cent. bone phosphate.

The fats obtained by either of these four methods are of good quality, and their percentage of free fatty acid is low, provided the bones were fresh and washed. Crushing the green bones is liable to increase the free fatty acid on account of the heating apt to occur in the crushing process. It is therefore better to use some water on the bones while they are passing through the crushers.

In preparing bones for the leaching process it is necessary to cook them in open vats only for such time as is required to allow the grease to separate and to loosen the meat and the sinews of the green bones. The glue liquors so obtained are very thin and should be concentrated by evaporation. The bones coming from the open vats must undergo a thorough washing with warm and finally with cold water, and if they are not used right away they must be dried before being stored. The bones should show a hard, yellowish surface, must be very tough and hard to break. The harder the better. The bones are then submerged into muriatic acid and remain there, according to the size of the bones, from three to six weeks, to dissolve the inorganic matter. After this time the bones appear soft, spongy, and have a strong odor (like country tallow). The bones prepared in this manner, called raw gelatine, form the raw material for manufacturing the best grades of bone glue and gelatine, very often superior to the best grades of hide glue.

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The Cooking of Various Cattle Bones for Glue.

The following gives further details regarding the glues obtained in cooking the various cattle bones:

The bullock furnishes

"Killing Bones:"

Heads,
Feet,
Jaw bones,
Round and flat shin bones.

"Cutting Bones:"

Ribs,
Shoulder blades,
Shoulder bones,
Rump bones,
Shank bones,
Knuckle bones,
Thigh bones.

Glue liquors obtained by cooking the so-called marrow bones, viz., round and flat shin bones, thigh, buttock, blade and shoulder bones, are so dilute that they frequently do not pay for the necessary concentration by evaporation. The manner of cooking these bones has been described. The main object in cooking same is to obtain a first-class bone either for gelatine or for cutlery purposes.

Cooking of the cattle bones furnishes two distinctly different grades of glue:

(1) Foot glue, obtained from cattle feet.

(2) Head glue, obtained from the rest of the bones. In some factories the glue liquor from the killing bones is kept separate and furnishes a third liquor for

(3) Canning glue, which is, however, of one quality with the head glue.

(1) FOOT GLUE.—The cattle feet are first sub-

jected to a thorough washing process, which is to remove the bulk of the blood and the manure. Where the packer is not directly interested in the glue factory, his washing process is frequently not as complete as it is desirable, though improvements are made rapidly as the packers become interested in the glue business. The washed feet are stripped of their sinews and turned over to the sawyer, who makes two cuts on each foot, obtaining the knuckles and the flat and round shins. The knuckles are thrown into boiling hot water, remain there ten minutes, which loosens the hoofs, so that the hoof can readily be knocked off or punched off. The knuckles are then washed again, and furnish now the raw material for the foot glue. They are thrown into the cooker, covered with fresh and clean water. After two to four hours the water is saturated with blood, and allowed to run away. The knuckles are now covered with a solution of sulphurous acid in water of a density of 1° B., and are allowed to stand for ten or twelve hours. The knuckles swell up considerably and are partly bleached. This liquor, too, is run off, and fresh water run on; then steam is turned on. The cooking, usually in open wooden vats, must be done very carefully, very slowly. The temperature should not rise above 200 or 210° F. After six hours the steam is turned off. The liquor is allowed to settle. The oil (neatsfoot oil) forms a clear light yellow layer on top, and is carefully skimmed off. The glue liquor itself, which has a density of 1½ to 2° Baumé, and is of a light yellow color and very clear, is allowed to settle for one hour, and is then slowly drawn off. A solution of sulphurous acid of ⅓° Baumé is then put on the knuckles and steam turned on again for six hours. The neatsfoot oil collecting again on top is skimmed off; the glue liquor is allowed to settle, and drawn off. This second run combined with the first run furnishes a glue liquor requiring no further treatment, except evaporation in a vacuum pan, cooling, cutting and drying; occasionally it is colored with zinc white. Cattle foot glue obtained in this manner is of a light yellow or light brown color, breaks like a hide glue, shows a good "body" in solution and gives strong jellies.

(2) CATTLE HEAD GLUE.—Cattle heads, jaw bones, rump bones, shanks, knuckles and ribs give all a similar glue, and are therefore worked up together if these bones are to be converted into "bone meal," glue, etc. If it is the intention to produce "raw bone" from some of these bones, the method is somewhat different. In the first case the bones are crushed to the size of a fist, and are thoroughly washed to remove blood, etc. The wash waters are apt to carry away a good deal of fat, and should therefore pass a clean catch basin, which will save the fat in a form which can be turned into something better than tallow. The bones, of a nice white color, are taken to the cooker, covered with a 1 per cent. solution of sulphurous acid, and remain so for six hours. The first acid solution is then run off and replaced by fresh acid solution, which after six hours' standing is replaced by clear fresh water. In this water the bones are slowly cooked for six hours at a low temperature (200° F.) A heavy layer of nice clear tallow collects on top of the liquor; this tallow is of a very good hardness and shows about ½ to 1 per cent. free fatty acids. The liquor is allowed to settle for one hour, and is then slowly run off; it is water-white and clear. The bones in the cookers are covered a second time with water, mixed with 25 per cent. of a 1° acid solution, and cooked a second time for six hours. After this time the tallow is skimmed off, and the glue liquor allowed to run off. First and second runs combined give, evaporated, cut and dried, a glue either colorless or of a light yellowish color and of ex-

cellent quality. The last runs of the crushed cattle bones give, with the last runs of the cattle feet, a nice bone glue. Very often they are clarified, and give a nice looking glue. Some glue factories, but very few nowadays, turn the cattle feet, heads and jaw bones into raw bone instead of bone meal. In this case only two boilings of the feet and one of the heads are to be made, and the cooked material is to be separated into knuckle bones, skull bones and tankage. This tankage, containing much glue and oil, is cooked again with sulphurous acid, and this cooking is repeated. Cattle feet treated in this manner yield per bullock about

1 pound neatsfoot oil,
1½ pounds of glue.
3 pounds of raw bone,
½ pound of tankage.

If the bones are worked up into bone meal the yield per bullock is:

1 pound neatsfoot oil
2 pounds of glue or
3 pounds of bone meal.

The neatsfoot oil made by the use of sulphurous acid has 0.3 to 0.5 per cent. free fatty acid, is light in color and free of any specific smell.

The cattle feet may be cooked without sulphurous acid, but the glue obtained is then of dark color and generally poorer in quality, while the neatsfoot oil takes on a characteristic, at times objectionable smell, is darker in color, and shows 0.2 to 0.3 per cent. free fatty acid.

Jaw bones are principally cooked for hard bones, giving excellent material for making (1) white raw bones with 5 to 5½ per cent. ammonia, or (2) poultry bones, or (3) bicycle bones for steel hardening.

Instead of using fresh water, as mentioned several times in this article, warm water from condensers, vacuum pans, etc., can be used to great advantage.

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The Leaching of Hard Bones and Horn Piths.

Hard bones and horn piths can be manufactured into glue and bone meal by prolonged cooking. The yield of the glue thus produced varies between 6 and 15 per cent.; the time of cooking, if done in open vats, from thirty-six to forty-eight hours. The quality of such glue is poor. In order to make fine grades of glue or gelatine from bones and piths, it is necessary to leach them in acid; muriatic or phosphoric acids answer for the purpose. These acids dissolve the inorganic substances of the bones and piths without injury in any way to the raw gelatine or organic substance, if handled with proper care. Furthermore the acids take up a great part of the coloring matter and of the offensive smell. Muriatic acid works quick, dissolving the inorganic substance readily, and may cause heating of the bones by too rapid action, which must be avoided if good quality of gelatine and full yields of same are desired. It requires constant watching, especially during the first days, while the carbonates go into solution. Bones crushed too fine require extra close attention. The following points must be strictly observed:

First—The vats should not be crowded with raw material to the top, on account of the swelling of same in contact with acid. The vats should be filled within about one foot from the top.

Second—Muriatic acid should not be used any stronger than 2° B., and must be free of sulphuric acid; one-tenth of 1 per cent. is the maximum of sulphuric acid which can be allowed. Muriatic acid must further be as free as possible from arsenic and iron. It shall also contain only very small quantities of salt. If stronger acid than 2° B. is used it will heat the bones and dissolve the gelatine. The bones will then get smeary and soft, instead of being spongy.

Third—If phosphoric acid is used it can be about 6° B., as this acid acts slower, and is, therefore, accompanied by less danger of heating and spoiling the raw material; but it is essential to have the phosphoric acid free of sulphuric and fluoric acids. The sulphuric acid will turn the bones white, making them hard, forming an incrustation of sulphate of lime throughout the raw material and thereby stopping the leaching process entirely, causing great loss of acid as well as bone.

Fourth—The water for diluting the acids should be pure; if possible, condensed water is to be used, which is free from salts.

Fifth—The first quantity of acids which is used on bones and piths usually shows a heavy foam, very often of dark color, on account of the dirt gathered in it. It is advisable to remove this dirty foam. This foaming lasts but a few hours, and the acid must be run off before it ceases, as in that case the acid is saturated, and if left on the bones any longer will turn the bones white.

Sixth—During the first week the acid is to be changed once every day, and is to be tested to ascertain whether it is saturated with phosphate of lime or not. During the second and following week the acid is allowed to remain on the bones and piths for several days.

Seventh—The leaching vats should be in a cool place.

Eighth—Samples of bones are frequently tested with a knife to ascertain whether the process of leaching is finished. If the bones or piths can be cut in every direction and show a spongy texture all the way through, the acid is run off and replaced by clean water, which is renewed as often as necessary, until the last wash water does not show any degree on the Baumé scale. The muriatic acid, 2° B., when saturated with phosphate of lime, will show 7° to 8° B. The phosphoric solution of 6° B. when saturated will show 8° to 9° B. By testing the acid with a hydrometer it can be readily seen whether the process of leaching is becoming complete or not. The leaching vats are provided with perforated false bottoms and with durable stone or wood faucets, which faucets must be put in hot tallow before being used, otherwise they get leaky in an extremely short time. The leached and washed bones or piths, as they come from the leaching vats, form a material which, by cooking, etc., is manufactured into fine glues and gelatine. The yields of dry, raw gelatine are 25 per cent. from bones and 33 per cent. from dry piths. The dry, raw gelatine yields from 80 to 90 per cent. of glue. The time of leaching varies from six to eight weeks.

The Temperature for Cooking Glue.

To boil water at ordinary atmospheric pressure requires a temperature of 212° F. To bring glue liquor to boil under the same conditions requires a temperature a few degrees above 212°, according to the amount of glue dissolved in the water. It would, therefore, appear that the gluemaker would have to use a temperature of 212° and higher in cooking his glue stock; but a gluemaker must make every effort to reduce the temperature at which the raw material softens and dissolves in the water. In a properly conducted process of cooking glue stock real cooking or boiling of the stock will be avoided as much as possible. The gluemaker must bear in mind that the lower the temperature and the quicker the material dissolves in water, the better the quality of the glue produced. Prolonged heating of glue liquors will make weak glues, will cause same to foam and will impart to them a brown color and a strong, offensive smell.

Green glue stock requires cooking for a long time, as long as twenty-four hours, at a temperature of 212° and above, and will, therefore, yield a poor grade of glue. Liming of the raw material loosens the stock, softens it and accelerates its solution in hot water. Properly prepared lime glue stock, with the aid of hot water, will give a glue liquor of 1°, B. in about one-half an hour. By reducing the raw material into fine shreds, agitating same in kettle, while the hot water is allowed to act upon it, will shorten the time and reduce the temperature required to dissolve this stock. Properly limed glue cut up in shreds and agitated requires hardly any steam for a complete solution; boiling hot water will do the work, and sometimes the temperature of 180° F. will be sufficient to cut the time down to less than one-half hour for each run. For the last runs, however, it will be advisable to use some steam to get a full yield of glue, especially when heavy and thick pieces of pates, ears and tails are used. Glues produced in this manner have a very nice appearance and show a high degree of strength. The one inconvenience which such glue liquors have, however, is that they require a long time for separating impurities and grease from them, if clear glues and glues free from grease are aimed at. The time which the glue liquors remain in the cookers or kettles is so short that practically no separation can be effected in the kettle, and, therefore, if such separation is desired it must be obtained in special settling vats.

Sulphurous acid possesses the same action as lime in preparing the raw material for easy and rapid solution. Sulphurous acid makes the glue soft, shortens the time of cooking and likewise the temperature required to dissolve the stock, but great care is necessary in utilizing sulphurous acid for this purpose. If sulphurous acid is used in excess the glue will show to be strong in free acid, and will destroy colors if applied on colored paper; furthermore, glues treated with an excess of sulphurous acid will show an offensive piggish smell, and a very low "body" test. Such glues will dry very slowly and will foam if applied with revolving brushes.

Bones should be treated in a similar way as hide glue. Uncrushed bones give a poor glue, but when crushed they give a nice, strong liquor inside of three hours, while uncrushed bones require ten hours' cooking at least. Sulphurous acid has the same effect on bones as on hide glue.

Bertram's process is nothing but a cooking of glue at a very low temperature, about 160° to 170° F. in a jacketed kettle or a water-bath, where steam does not come in contact at all with the glue liquors. High pressure steam of 80 lbs. will show a temperature of 325° F. It is very hazardous to run such high steam pressure into glue liquors, as it can change a glue almost instantly into "stick," but we have seen glue made from sheep stock by Bertram's process which was just as good as the best hide glue stock ever produced in the United States.

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The Bleaching of Glues.

The natural color of glue, or rather the color of glue as produced from the different raw materials, varies from a dark brown to a light yellow, and even to water white. It is this color which furnishes to the manufacturer as well as the consumer, the very best indications in regard to the amount of care which has been taken in the manufacture of this glue. Dark brown glues show carelessness in their manipulation, while yellow or colorless glues are a sure sign of great care used in the treating of the stock, as well as of the glue liquors.

Country bones, green bones and green glue stock produce dark glues if boiled directly without any previous treatment. Glues produced in this manner have an offensive smell, and if dissolved in hot water tell directly from what raw material these glues have been prepared. It must, therefore, be the tendency of the glue manufacturer to produce his glues of as light a color as possible. This can be accomplished by the following methods: First, curing the raw material; second, bleaching the glue liquor either before or after evaporation; third, in combining both of the above methods.

The proper preparation of bones requires a great deal of washing, and this is best done with sulphurous acid, and continued until all offensive odor has disappeared. Bones washed in this manner and cooked with a very dilute solution of sulphurous acid, using such solution for each run of liquor to be produced, are of a very satisfactory color.

Green glue stock requires a more complicated treatment, consisting in assorting, washing and liming stock, then washing such limed stock, cutting same into small pieces, and finally treating the stock with sulphurous acid solution until the lime has been completely neutralized. In Germany limed stock is treated with chloride of lime and muriatic acid for about half an hour and is then thoroughly washed. Care must be taken that this treatment is not continued too long, as otherwise the stock is thereby rendered hard and almost insoluble. Stock treated properly in this manner gives very light colored glues (Cologne glues), at least from the first runs; the last runs furnish glues of a darker color.

During the summer, when limed stock cannot be converted into glue, all of it is dried either by sun heat or artificially with the aid of an air current. Sun-dried stock is very well bleached and gives nice, light colored glues of a very high body test.

The bleaching of glue liquors can be done by pumping sulphurous acid into the liquor until the required light color is obtained. Another effective method is to use powdered zinc (zinc dust) and sulphurous acid. The use of zinc dust has only one decided drawback, and that is its tendency to make glues produced by their aid of a low body test and to cause the glues to foam badly. Chloride of zinc and sulphate of zinc have been used advantageously for lighting the color of glue, but the same disagreeable results (low body test and foaming) are to be feared if these materials are not carefully used. The use of sulphate of zinc, if applied to thin liquors, has also another disadvantage, in as far as it causes difficulty in the evaporation on account of the formation of sulphate of lime and the incrustation formed thereby on the heating surface of the evaporator. It is, therefore, better to use sulphate of zinc on concentrated glue liquors rather than on the weak solutions.

Peroxide of hydrogen has been used very successfully on glue liquors. It turns the darkest brown into a light yellow. Against its general adoption two factors exist;

the one, the high price of the material, and the other, the great danger of turning the glue into "stick."

Proper care in the drying of the glues will materially improve their color. If dried in lighted alleys they are bleached materially on the surface, and the result is naturally more noticeable on thin shreds. Very good results are also obtained if a small percentage of sulphurous acid is used combined with the air current in the drying process.

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Preservatives For Glue.

There is hardly another substance of organic nature which decomposes so rapidly as glue, especially at temperatures from 80° to 120° F., which are most dangerous for souring and fermenting all organic products. The different stages of souring of weak glue liquors are well known to the practical manufacturer. At first the clear liquor starts to turn a milky white and to form a light foam on its surface; later on the characteristic smell of souring glue can be noticed. If the decomposition is not stopped the glue liquors begin to assume a dark color, a strong odor and a distinctly acid reaction. Such sour liquors are difficult to evaporate; they foam badly and give a poor glue.

If a strong evaporated liquor is allowed to turn sour the solid glue jelly will show a convex surface. The glue jelly is full of holes, and if too far decomposed cannot be cut, as in attempting to do so it crumbles to pieces. Such glue jelly has a dark greenish color and a very strong odor of sulphurated hydrogen. Cutting and drying of such glues offers great difficulties. Very few decomposed glues will set at all in the coolers, and are therefore a dead loss. Glues which sour during the drying process show in the first stages a silky white surface which, under the magnifying glass, appears to be a complexity of very small holes, these holes increasing as the decomposition continues; but they are distinctly different from the ones caused by too rapid drying.

Sour glues cause great damage and loss in glue factories and frequently bring endless difficulties, as it is very often almost impossible, with existing conditions, to locate the real cause of it. Carefully prepared glues do not require any preservative, or, in other words, substances which are supposed to make good everything that has been neglected during previous stages of the manufacture. The best preservative for glue is undoubtedly sulphurous acid. It gives to the manufacturer an excellent material for bleaching glue and to prevent the souring of same. If limed stock treated with sulphurous acid did not receive a thorough washing the dry glue will show either a rough, whitish surface, or it will be full of white spots, which are nothing else but crystallized sulphite of lime. Quick drying and coloring of glue with zinc white prevents the crystallization of the sulphite of lime. Boracic acid, although an excellent preservative for meats, has little effect on glues. It has to be used in large quantities to be effective, making its use rather too expensive. A very preferable preservative for our purposes are zinc salts, either oxide alone for coloring, or in the form of sulphate or chloride of zinc. Sulphate of zinc has a similar effect on dry glues as sulphurous acid; it makes glues white on account of crystallization of sulphite of lime. Furthermore, it gives the glue a tendency to foam in the evaporation, and therefore should preferably be used on thick glue liquors. Chloride of zinc leaves the glues clear without any white specks, but retards the drying very much, owing to the formation of chloride of calcium in the glue, which chloride of calcium being of a very hygroscopic nature, retains moisture with great energy. Dry glues containing such chloride of calcium, if allowed to stand for some time, will become soft and flexible, gaining considerable weight, to our own experience, as much as 5 per cent.

Bichloride of mercury is a very strong preservative, but darkens the glue; furthermore, it is too expensive and too poisonous for ordinary use. Alum is a good preservative, but is liable to give glues a flaky appearance if proper care is not taken.

A new preservative has lately been proposed and recommended for glues and glue liquors. This preservative, formaldehyde, introduced under fancy names of formaline, formalose and numerous other ones, is a very powerful antiseptic. A very small quantity of it is sufficient to keep glues indefinitely, one-quarter per cent. being the maximum quantity required and allowed. If applied in large proportions it forms an insoluble compound with the glue, and care is therefore required in the application of this otherwise excellent preservative.

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About the Foaming of Glue.

If a hot glue solution is kept in constant motion, either by agitating same with a stick, or with revolving brushes, and if the surface of such glue liquor becomes covered with white air bubbles, which do not disappear, even after the liquor has been allowed to stand for a while without any agitation, we say that such glue liquors foam. According to the quality and height of the foam and the time required to produce same, the glue is said to be foaming badly, lightly or not at all. Badly foaming glues cause a great deal of trouble when applied with revolving brushes on veneers in the following manner: A great deal of the foam is pulled in between two veneers into the joint and it is this enclosed and pressed air which prevents the glue from soaking into the wood. The veneers are pressed together, until the glue is dried. If the outside pressure is then removed, the compressed air will cause the veneer to split in the joint and thereby cause a great deal of damage. It is therefore not surprising to hear that sewing machine works, car builders, etc., do not want a foaming glue at any price, and reject everything which does not suit them in this respect. We can safely say that with a few exceptions all imported glues foam. We do find a good many glues made in the United States which foam badly; as a general rule, however, the American glues show this undesirable property less than the imported ones.

About the nature of the substance which causes the glue to foam very little is known, and the problem how to avoid it is as yet an unsettled question. Ten years ago the manufacturers of glue had no trouble in this respect, but with the constantly increasing use of improved machinery for applying the glue the question of foaming glues has become very serious, almost as much so as the question of greasy glues in the wall paper trade.

The following conditions are liable to cause glues to become foamy: Prolonged cooking either in open vats or under pressure will produce a foaming glue. It is, therefore, most desirable to prepare the glue stock so that it will yield glue liquor in a short time at a comparatively low temperature. Bones should be crushed and glue stock limed and both kept in motion while in the cooker. Caustic lime will also cause glue to foam, especially at a temperature of 180° to 210° F. It is, therefore, a matter of importance to have limed glue stock well washed with water than with acid and with water again, though it is almost impossible to have a stock perfectly neutral, as it will always contain some caustic lime, especially in the large and heavy pieces, pates, ears, tails, etc. Furthermore, it is desirable to make as many runs of glue liquor as practically possible, as the last trace of caustic of lime are well neutralized by bicarbonate of lime contained in the water used for cooking glue. The more water and the more bicarbonates come in action, the more dangerous action of the caustic of lime on the glue is reduced to a minimum. Another cause of the foaming is the use of acids either in the cooker or in the ready glue liquor. All glue liquors produced by cooking with an excess of acids will give foaming glues; also glue liquors treated with acids either for bleaching or for clarifying or with zinc salts for preserving, are liable to give foaming glues. Great care is therefore to be taken in treating glue liquors for bleaching, clarifying or preserving not to overdo the treatment if the glues obtained shall be free of the undesirable property. Glues colored with zinc white have also a tendency to foam.

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How to Make Sweet Glues.

It is a well-known fact to every one using dry glues that it is not advisable to dissolve more of the glue than is required for a day's work, on account of the following reasons: When dissolving glue you will notice the impurities to separate. Pieces of wood, straw, etc., either rise to the top or settle to the bottom, leaving a clear glue solution which will give little trouble in its use, providing the proper quality of glue was dissolved in the amount of water suited for the special purpose. This glue is kept during working hours at a temperature of 170° to 180° F., being stirred constantly to prevent its drying on the surface or its clarification. As this is done generally on the water-bath, the quality of the glue suffers but little. This glue solution, during the day's work, becomes dirty, and it can be frequently noticed that the glue which had a light yellow or brownish color in the morning, is dark or black in the evening. It is easy to understand why such remnants should not be used the next day or fresh glue mixed with them. In the first place, it cannot be relied upon, as such glue is liable to become sour in a very short time, especially in rooms where hundreds of men are working. Yet consumers of glue demand that glue should keep sweet at least for two days after being dissolved, and kept at a temperature of 170° to 180°. It must, therefore, be the effort of the glue manufacturers to meet this requirement. In a previous article we discussed how, by the aid of chemicals, this can be accomplished. Without chemicals it is difficult, but still possible, to obtain this end. To produce glue answering for such purpose the raw material must be sweet. If blue or black pieces should be present, the washing process must be prolonged. The liming must be perfect, and the washing of the lime stock must be likewise, and the material before it goes in the cookers must be perfectly sound. Some glue factories are using muriatic acid to remove the lime in order to obtain an extra nice looking, clear glue; but if such acid is used great care must be taken that all of the chloride of calcium is washed out of it, as glue containing such chlorides is liable to become sour in the vacuum pan. Whether such stock has been properly freed of any chlorides can be easily ascertained with nitric acid or nitrate of silver. Sulphuric acid has not such a bad effect. Generally speaking, the washing process has to be done in such a manner that the glue either shows a slight acid or alkaline reaction. Neutral glues sour very quickly.

The glue taken from the cookers must be put through the evaporating and cooling process with the greatest haste. The temperature of the glue liquor coming from the pan at 130° F. must be reduced as rapidly as possible and the glue must be allowed to "set" in the shortest time. This is accomplished by artificial cooling, either by cold air or by allowing the glue liquor to run over cooled metal sheets, or in any of the various ways which we have described in previous issues. Of course, such coolers of whatever form they may be, must be scrupulously clean. The drying process must be such that glue cut in the morning can be stripped in the evening, or at least the next morning. Kettles, receivers, evaporators, etc., must be perfectly clean. No cuttings or scrapings are allowed to be mixed with such glue. It is far better to work up such cuttings (tops and bottoms) by themselves. The dry glue is tested in regard to its sweetness by dissolving one part of glue in about three or four parts of water and placing the resulting liquor in a room having a temperature of 120° to 130° F. Steam is allowed to enter such room to keep the air uniformly moist in summer as well as winter. The glue is examined from time to time by being stirred up by by testing it for sweetness. The samples which have turned sour are removed from the test room. The hours required to sour these samples are taken as the measure for the sweetness of such glue.

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About New Glue Tests.

Satisfactory glue tests are still a thing very much to be desired. The ordinary tests of glue for strength, body, reaction, color, water, absorption, sweetness, etc., give fairly reliable results, but every one experienced in glue tests will admit that new and better methods would be much appreciated; in fact, they are indispensable before we can expect that the glue trade will generally recognize glue tests as a desirable and necessary basis for glue transactions, and as a proper and reliable control of the glue manufacture.

Fahrion has proposed a method which, complicated as it does appear, may bring us nearer to the desired object. Fahrion digests glue shavings with an 8 per cent. alcoholic solution of caustic soda, and reduces the product to dryness. He treats again with alcohol, evaporates again, and treats the residue with hot water, washes it into a separatory funnel, acidulates with muriatic acid, and allows to cool. The cold solution is extracted with ether, which dissolves unsaponifiable matter, fatty acids and the liquid oxy-acids; the latter can be separated by petrol-ether, which does not dissolve them. The solid oxy-acids remain in the aqueous solution; they are dissolved in warm alcohol and determined by evaporating the alcoholic solution and weighing the residue. To separate the unsaponifiable matter from the fatty acids the petrol-ether solution is treated by a solution of caustic soda in dilute alcohol. A sample of the glue analyzed in this manner gave this result: Water, 13.74 per cent.; ash, 1.80 per cent.; unsaponifiable matter, 0.49 per cent.; fatty acids, 0.08 per cent.; liquid oxy-acids, 0.04 per cent.; solid oxy-acid, 0.27 per cent.; protein matter, 83.58 per cent. The method may give valuable information regarding the chemical constitution of the glue substance, but will hardly be of value for testing glues for commercial purposes.

Kissling recommends the following glue tests: 100 grams glue are soaked in 300 cc. water, and then brought to an even solution on a water-bath. Pieces of wood are jointed together with this solution on their cross-cut ends, using the ordinary precautions. The joint surfaces are pressed together for twenty-four hours, and allowed to remain in a dry room for forty-eight hours longer before the actual test is made. The jointed piece is screwed to a table so that the joint sticks 10 mm. over the edge of the table. At 200 mm. from the joint the force is applied which is to break the joint; i. e., a plate is suspended at that point which is to receive the weights. The start is made with 5 kilos; the weight is increased 1 kilo every minute till the stick breaks. The resistance calculated for 1 gcm. of the glued surface is equal to — $p \times l : h^3$, p signifying the weight, l the length of the lever, h the width and height of the glued surface. The water absorbing capacity of the glue is determined by placing glue in water and ascertaining the weight of the glue from time to time till it falls to pieces. Consistency and stiffness of the glue jelly is measured by the time necessary for a metal or glass rod to sink into the jelly.

Gantter tests glue as follows: 100 grams glue are boiled with one liter of slightly alkaline water till dissolved; the solution is then diluted to 2 liters. After settling for ten hours 20 cc. of this solution (equivalent to 1 gram glue) are evaporated, dried, weighed and reduced to ashes. Thus the crude glue, free of ash, is ascertained. Further 10 cc. are diluted with 30 cc. water, neutralized with acetic acid, and so much tannin solution added till no further precipitate is produced. The solution is diluted to 100 cc., filtered, treated with hide powder to remove the excess of tannin, filtered after ten hours and 50 cc. evaporated to determine the dry substance (non-gelatinous matter). These data allow the calculation of the amount of pure glue.

Wischin proposes a test which is very similar to Kissling's test, and another resembling the long known test of Lipowitz. George Seligman obtained a patent on a glue testing apparatus, based on the assumption that the adhesive strength of glue is in direct ratio with the amount of matter which glue can absorb before it is torn by its own weight if suspended under certain conditions. The results of this apparatus are not very promising.

C. Stelling, in view of the difficulties met with in the direct determination of chondrin and gelatine, determines the non-gelatinous constituents of commercial glue. To this end 15 grams of the glue to be tested are placed in a 250 cc. flask, covered with 60 cc. of water and left for twelve hours. The flask is next heated on the water-bath till complete solution of the glue is effected. The water evaporated from the flask in accomplishing this, having been replaced, the flask is filled almost to the mark with alcohol of 96°, shaking the flask meanwhile constantly. It is then allowed to cool, filled to the mark, and well shaken. After six hours the liquor is filtered, 25 or 50 cc. of the filtrate are evaporated to dryness, the residue dried at 100°C. and weighed. The method yields only approximately accurate results, but it is trustworthy and useful for comparative tests. Some of the results obtained are:

Gelatine.—Five samples gave 2.53 to 4.53 per cent., or an average of 3.39 per cent. non-gelatinous compounds.

Hide Glue.—Three samples gave 4.30 to 7.60 per cent., or an average of 5.73 per cent. non-gelatinous compounds.

"Peddig" Glue.—Five samples gave 2.00 to 4.70 per cent., or an average of 3.49 per cent. non-gelatinous compounds.

Bone Glue (from bones partly extracted with muriatic acid).—First run, four samples gave 9.24-11.84 per cent. non-gelatinous compounds; second run, three samples gave 13.16 to 16.78 per cent., or an average of 15.15 per cent. non-gelatinous compounds.

Bone Glue (from not or barely acidulated bones, cooked under pressure).—Seventeen samples gave 14.30 to 32.10 per cent., or an average of 20.66 per cent. non-gelatinous compounds.

Glue for Clarifying Wine.—Two samples gave 32.20 and 59.30 per cent. of non-gelatinous compounds.

The difference in the amount of non-gelatinous compounds is sufficient to allow a conclusion regarding the source and manufacture of a glue sample.

The arguments which Stelling advances in favor of his method are as follows: The adhesive strength of glue depends upon the amount of gelatine resp. chondrin contained in the glue, and is principally influenced by the amount of decomposition products resulting from the above materials during the course of manufacture. The amount of these decomposition products, which may be termed non-gelatine or non-gelatinous compounds, depends, sound glue stock assumed, on the time and temperature used in the manufacture of the glue. Glue liquors produced at a temperature below 212° F. and "set" in the shortest time possible, contain, therefore, much less non-gelatine than liquors produced under pressure at a higher temperature or by a slow process. It is therefore possible to draw conclusions from the amount of non-gelatine, not only in regard to the adhesive strength, but also regarding the process of manufacture. At all events the determination of the non-gelatine furnishes a better idea regarding the quality of glue than its behavior toward tannin or its water absorbing capacity. Non-gelatine acts upon tannin exactly like the non-decomposed gelatine, and the water absorbing capacity is in a large measure dependent upon the concentration of the jelly from which the glue has been cut. Glue produced from jelly of 10° Bé. absorbs in the same time two or three times as much water as glue produced from the same liquor, but concentrated to a jelly of 16° Bé.

Kissling states that the results of his experience of years in testing glues led him to the following conclusions: The complete technical analysis of glue must embrace the determination of water, mineral substances, fat, free volatile acid (sulphurous acid), combined volatile acid, strength of the jelly and the odor and color. The water absorption of glue gives no information regarding the quality and character of glue. Furthermore, there is no reliable method free of objectionable features which allows the determination of the adhesive power. To determine moisture, ash and odor of the glue, it is cut into shavings, which are dried at 105° to 110° C. and reduced to ashes. The figures thus obtained, regarding the amount of moisture and mineral substances, are of little importance. The odor of glue is characteristic; to express same in figures Kissling uses six standard samples, usually preserved in glass stoppered bottles. There is no trouble, with such samples on hand, to characterize the odor of a glue. Regarding the color, Kissling does not make any special suggestions. The amount of fat he determines as follows: 20 grams glue are dissolved in a 200 cc. jar in a mixture of 140 cc. water and 10 cc. muriatic acid of 1.19 specific gravity by heating the solution for three or four hours on a water-bath; then allow to cool, and add 50 cc. carefully refined petrol-ether. Continued shaking will dissolve all the fat; after complete separation of the ether from the liquor an aliquot part of the ether solution is evaporated to determine the fat.

MEMORANDA

Recent Improvements and Inventions in the Manufacture of Glue.

Improvements in the manufacture of glue are usually kept secret as far as possible; it is, therefore, frequently impossible to obtain satisfactory information regarding such new processes and machineries, and the most that can be done to bring such matters to the knowledge of the trade in general, is to call attention to the fact that such improvements are claimed or rumored about. Occasionally this may be sufficient to assist interested parties to secure desired knowledge.

Wolff (Heilbronn, Germany, German Patent No. 69,463) produces glue or gelatine in plates of any desired thickness by running the liquid jelly upon an endless apron, carried on revolving cylinders. The edges of this apron are turned up by suitable boards, thus producing a flat groove, preventing the liquid mass from running off the edges of the apron. Several of such aprons are combined to permit sufficiently long exposure of the glue ribbon to a drying air current to allow the glue to become dry enough to go to the usual cutting and drying apparatus. The air current is readily controlled by placing the aprons in a box through which the air current is forced. Suitable scrapers remove the gelatine ribbon from the aprons. This apparatus recalls to memory the process of P. C. Hewitt. The principle of Hewitt's apparatus, however, is radically different. Hewitt passes the jelly over cooled rolls, allowing the jelly to set, before the ribbon passes off unto an endless apron, etc.

H. Allenbach proposes to prepare and dry glue liquor by running it on an endless apron of suitable metal, passing over steam heated drums.

Kind and Landesmann have a large glue factory (at Aussig, near Vienna) where they manufacture hide glue and gelatine of highest purity, with the aid of mechanical means only, entirely avoiding the use of acids or other chemicals.

Grillo and Schroder, in Neumühl-Hamborn, are using compressed sulphurous acid for extracting the fat from bones, which solvent has its advantages, but also serious drawbacks. At all events, the manufacturers of bone glue are watching with a great deal of interest the future developments of this experiment. The same inventors obtained a patent for treating the air dry, or moistened bones with sulphurous acid gas in sufficient quantity to transform the tribasic calcium phosphate of the bones into bibasic phosphate and sulphite of calcium. The bones are thus rendered extremely brittle; they are in this condition readily extracted with boiling water; the resulting glue liquor is freed of soluble acid lime salts by precipitation with milk of lime and worked up in the usual manner.

Brand, in Rostock, Germany, adds a hot solution of borax and potash to the hot glue liquor, obtaining a jelly which does not readily sour.

Goldschmidt, in Berlin, adds 5 to 7 per cent. sulphocyanate of ammonium to glue and water; the glue is dissolved by heating; allowed to stand for a few days, when it becomes again liquid, to remain so, without turning sour.

Spencer, in London, produces gelatine in the form of thin scales, by granulating gelatine, screening off the fine powder and passing the coarser grains between smooth rolls. The scales thus produced are as readily soluble as the powdered gelatine, but to show the tendency of the latter to bake together and form lumps, which dissolve rather slowly.

R. Reissner and Hauser (Erlangen, Germany) obtained an English patent to render glue insoluble by adding a solution of formaldehyde.

E. Wiese (Hamburg) proposes to make a quick drying glue, of good preserving qualities, by dissolving simultaneously glue and chloral hydrate in water.

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About the Cracking of Glued Joints.

It is an old established fact that various grades of glue require different lengths of time for drying in joints. This is the reason why some goods start to crack in the joints when they are exposed to a dry and hot atmosphere during a certain period. According to the quality of the glue this happens in more or less pronounced manner, especially on veneers. With fast drying glues, if applied, great damage can be done in this respect, very frequently before the goods are even put on the market. This is naturally a great inconvenience to the manufacturer as well as the trade and the glue used on such articles is usually returned to its manufacturer, although the quality of the glue may have been pronounced as A1 by the various laboratories testing them. Very little attention is paid in testing glues as to its liability to crack in joints. Still this is of the greatest importance in certain trades. The lower the temperature used in manufacturing the glue the slower the glue will dry. Glues produced in a temperature of 160 degrees and below, may be called hygroscopic. Glues produced at 180 to 210 degrees, F., from well prepared stock, are generally fast drying glues. If, however, salt remains in such glues they will not dry so rapidly. Glues produced by boiling under high pressure up to 30 pounds are slow drying, sticky glues.

Green glues, i. e., glues which have not been cut, dried and redissolved, dry very slowly. As the largest quantities of glues are produced at 180 degrees F., and above, it is evident that most of the glues are fast drying, and will therefore have a tendency to crack in the joints if the goods manufactured with them are exposed to hot and dry air. Different remedies have been proposed to prevent this trouble. We mention: (1.) The addition of glucose or glycerine to the glue. Both of these substances remain liquid in hot rooms and prevent the glue from cracking, as they keep the joints in a somewhat moist condition; at the same time glucose and glycerine are mild preservatives. (2.) The incorporation of chloride of calcium in the stock. Chloride of calcium is very hygroscopic and retards the drying of glues very materially. (3.) The use of chloride of zinc in glues. This salt is also very hygroscopic and is a preservative at the same time. All these remedies will in the same manner cause the glue to dry slowly as well in the manufacture of the glue on the drying nets as in the practical use of such liquors when applied on joints; but these remedies at the same time decrease the strength of the glue to a certain extent. The last runs of bone liquor give slow drying glues on account of the prolonged cooking which these liquors receive either in open tanks or under pressure, and it is far better to run a small percentage of these slowly drying glue liquors into fast drying hide glues instead of adding the above mentioned salts. It is, of course, evident that glue liquors to be used in this manner must be sweet and free of any strong smell. For instance, it will not do to run the last runs of pigs' feet into hide glue liquors. Sometimes it is desired to accelerate the drying of the glue as in the case of the last runs of the bone glues and also of hide stock or fleshing. This can be accomplished by mixing such glue with a relatively large quantity of zinc white or whitening.

About the Cutting of Glue.

When the glue has acquired the desired consistency, the jelly is taken out to be cut into shreds. This is done in different ways, either by wire or by knife machines.

The wire machines consist of steel frames with steel wires, the latter set so much apart as to agree with the desired thickness of the glue shreds. There are principally two different kinds of wire machines: First, the old style, where the wire frame is moving, cutting the chunks of glue jelly, while the latter rests in a metallic box, thus assuring a perfect cut, while the chucks are held fast and prevented from slipping away from the wire. Second, the new style, where several frames are placed at a distance of from 1 to 2 feet, but each frame having only one steel wire, which wire is set in each successive steel frame so much lower than in the previous frame as the desired thickness of the shreds calls for. The whole jelly chunk is placed on an endless belt, which forwards it to be cut by the various wires. In this way there is always but one wire cutting at one time; the stress on the wire is, therefore, a very small one and the wires do not break easily and last a very long time. In the old style of wire machines the wires break quite frequently, and an extra set of frames must, therefore, be kept in readiness to prevent loss of time.

The knife machine consists of steel knives in form of blades in frames (old style) or in form of circular knives set on a shaft (new style). The old style knife machine resembles very much the old style wire machine, as the knives are moving, cutting the jelly in uniform sheets. Tops and bottoms from the cuttings of the jelly must be remelted. The new style of knife machines require the tops and bottoms of the jelly chunks to be scraped off.

Wire machines cut successfully light evaporated glues up to 10° B. Good testing hide glues cannot be cut by wire machines of more than 7° B. Low grade bone glues and last runs of hide stock, when evaporated to a heavier consistency, are generally cut with knife machines either in sheets to be put up in packages (packed glues), or in thin sheets to be crushed. In Europe where most of the glues are put on the market in nice sheets, the glue liquor is frequently poured out on glass plates in the required thickness and are then chilled and dried. Such glues have a smooth surface on both sides of the sheet.

We have had occasion before to speak of the machine which Mr. Hewitt is using, a machine which chills, sets and cuts the jelly in one operation and consists of revolving cylinders dipping into the warm glue liquors.

To inventors we will suggest the following idea: Have the glue cut with a wire machine and have an electric current running through the cutting wire, which current should be strong enough to heat the wire sufficiently to assist in cutting the glue. The wire should be just warm enough to cause the jelly in immediate contact with the wire to melt. This would give a smooth surface to the glue and also enable to cut even very heavily evaporated glues. One machine would probably do the entire work in a glue factory and do the work of several machines of the old style. [Interested parties could learn more from us regarding such a machine.—The National Provisioner.]

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About Hair From Glue Making.

Large quantities of hair are produced in washing and cooking limed glue stock. When washing the stock, the hair is separated with the aid of a suitable fork; it is important to have this done as completely as possible.

Most of the glue factories are not paying any attention to this point, claiming it does not pay to separate the hair and furhermore pretending that a certain amount of hair in the cooker is useful to obtain clearer glues, the hair acting as a filter. This little advantage, if it exists at all, is fully counterbalanced by the increased yield of fat in the cooker, if the hair has been previously separated. The green hair contains comparatively very little grease, but in the cooker where glue and grease are liberated from the stock, the hair becomes saturated with the grease and begins to float. It is a daily occurrence in glue factories to see hair, grease and glue in a mixture floating on top of the glue liquor in the cookers. Such hair, even if it were very carefully pressed, will always retain a large quantity of fat, thereby causing an absolute loss of such fat. Furthermore, it is difficult to understand how such hair floating on top of the liquor can act as a filtering material. Of course, if the bulk of the liquor is run off and the hair has formed a thick layer all over the bottom of the cooker, the last parts of the glue liquor will get the benefit of the strainer and accordingly will appear very nice and clear, but the bulk of the liquor has not been strained through this hair and is accordingly not as clear as the last portions of the run. The hair separated from the wash stock is comparatively pure while the hair from the cooker contains skins, bones, hoofs and limestone. There are several different ways of obtaining a commercial product from this hair.

First—Drying, especially in summer time. The dry hair is either used for wall plastering or for the manufacture of carbonate of ammonia or prussiate of potash. It may also be used when mixed with lime and asbestos to cover water and steam pipes. The lime required for this purpose is obtained by cleaning the lime vats and sewers in the lime department. The lime found there answers fully for this purpose.

Second—Cooking of the hair under 80 pounds pressure for six or eight hours. The greatest part of the hair is dissolved, forming a concentrated tank water. The undissolved part gives a very brittle substance, which can be readily ground. More than 50 per cent. of the fat in the hair is recovered by this process.

Third—Pressed hair is brought to a dry heat of 300 degrees F., which renders the hair brittle and easily ground into a powder containing 12 to 14 per cent. of ammonia. By this roasting process a good deal of the hair is converted into gases which escape and are an entire loss if not condensed by the aid of acid. The best way of carrying out this process is to fill the dryer (there are a number of good makes in the market), then close same and turn on steam for about ten to twelve hours. While there is no air coming in contact with the hair, there is no danger of its being set on fire.

Fourth—The hair is treated with a small amount of sulphuric acid and subsequently dried. The dry substance gives a brown powder containing 8 to 10 per cent. ammonia.

Fifth—In the manufacture of super phosphate, the hair is dissolved in sulphuric acid and heated until a uniform brown liquor is obtained, while in the surplus of acid ground meal or rock phosphate are dissolved. After a few days the product can be ground without being dried.

The residues from the lime sheep stock and lime fleshings may be treated in the same manner as hair. The ammonia in dried, not dissolved hair, is not available, while that in dissolved hair is about as good as the ammonia in blood, nitrates or ammonia salts. We think that some of the glue factory hair could be used instead of pig hair, if properly treated with sulphite of sodium, caustic soda, and finally dyed black. We think that such hair is a good deal more elastic than pig hair and can easily be mixed with the curled cattle hair.

From the above remarks it may be deducted that the hair is by no means a useless offal and it is surprising to see some glue factories burn their hair under their boiler in order to get rid of it. Of course hair containing 25 per cent. or more grease will burn with a large flame, but coal screenings are a great deal cheaper than hair as a steam producer. [We desire the glue factories to call upon us for help in this respect. Send us a sample of your hair and we will give you practical advice how to change your hair department eventually. Our work is strictly confidential.—The National Provisioner.]

MEMORANDA

Utilization of By-Products in the Manufacture of Glue.

TANK WATER.

Tank water is a liquor produced by the action of water and steam upon bones, hair, horns and hoofs. Liquors containing decomposed glue may also be classified as tank water. According to the length of the time of the cooking, the steam pressure employed and the kind of material used, the color of the tank water varies from a light brown to an almost deep black, and the percentage of dry matter in the liquor is from 5 to 12 per cent. Evaporated to dryness, tank water furnishes a dark brown colored solid mass, which may be reduced to a brown colored powder. This material has but very little of the properties of glue, and is very hygroscopic. If exposed in powdered form to a damp atmosphere, it will in a short time run together in a solid cake. This powder looks very much like ground glue, and contains about 16 per cent. ammonia.

A great many experiments have been made to reduce the tank water to a form of commercial fertilizer, which should neither cake nor run. The first process, which first solved in a more or less satisfactory degree the problem of reducing tank water to a fertilizer, is the one patented to Van Ruymbecke. According to this process the tank water is evaporated to a consistency of 25 to 30° B., and mixed with a certain amount of either sulphate of iron or sulphate of alumina. Of these chemicals (frequently called "medicines") sufficient must be added to the concentrated tank liquor to destroy its sticky qualities; the amount required can easily be determined. After the chemical has been added to the hot liquor and stirred for about one-half hour, a small sample is taken out and rubbed between two fingers. If the material remains sticky and does not dry out on the fingers, some more of the above named "medicines" must be added. When the stickiness has been thoroughly removed, the mixture is poured out into iron pans, being about 2 inches high and 24x36 inches. These pans, or trays, when filled to the proper depth (about 1½ inches), are put on steam pipes and a current of air is blown through the drying chamber to reduce the material to a dry cake; thirty-six hours are usually sufficient to obtain this object. The pans are then taken from the drying room and the dry substance is removed from the pans and ground. The ground powder, usually called concentrated tankage, contains 14 to 15 per cent. ammonia. The process, as described, has various drawbacks. The handling of a large amount of the material on trays requires a good deal of labor. The vapors coming off the material, when drying same on the pans, have a very corrosive action and soon destroy the pans, so much so that statistics show that the cost of renewing pans amounts to as much as $1 and over for each ton of the material dried. Furthermore, as the product under certain conditions does not entirely lose its hygroscopic properties, it may not be successfully used as a fertilizer.

About two years ago the drying of stick in pans was partly replaced by a new process, according to which the hot liquid mixture of "stick" and "medicine" is run onto steam heated cylinders. The hot liquid is spread on the surface of these cylinders in a thin layer, which, exposed to the heat of the drums and to a dry atmosphere, will dry out rapidly; so rapidly, in fact, that the dry material is obtained in one revolution of the cylinder. Dry concentrated tankage falls off continuously from the cylinder, while the feeding of the mixture is also a continuous one. It may be stated here that the cylinders have a perfectly smooth surface.

The process patented to Van Ruymbecke was a favorite for many years in the various glue factories and packing houses, but it is so expensive that it can only be operated profitably when the price of ammoniates is high. When the price of ammoniates is very low, the tank water finds its way into the sewers. Manufacturers have therefore looked for a cheaper process, which would always be on a paying basis and would not necessitate the paying of high patent royalties.

One of the most successful ways is to dry the concentrated liquor with a certain quantity of offal, bristle or cattle hair. All the offal hair from glue factories can be used for this purpose; the hair from the green lime stock, as well as the hair residue from cooking this stock. The fertilizer is produced in a brown powder and contains 14 to 16 per cent. ammonia. Another way is to mix with pressed tankage and dry this mixture in tube dryers. Great care is to be taken when using these two methods. The concentrated stick must be kept hot and must not be too heavy; a solution containing about 30 per cent. dry substance is most suitable.

Only such quantities of the concentrated liquor must be mixed into the tankage as can readily be absorbed by this tankage. If large quantities of the tank liquor are added the mixture will cause trouble in the dryers. The tube will become covered with a heavy layer of the solid material, which has to be removed by chisel. It may also cause the dryer shaft to break. Tankage thus produced is of a dark brown color, and much heavier than the ordinary tankage. It contains between 10 and 11 per cent. of ammonia. By working in this manner all tankage can be turned out as so-called high grade tankage of 10 per cent. ammonia and more, and will, in this form, bring the highest price. In large fertilizer factories where soluble phosphates are produced by dissolving Carolina rock or bone in sulphuric acid, a great deal of this tank water can be used for diluting the sulphuric acid, instead of mixing water with it. The entire amount of ammonia is utilized in this manner, and is contained in the resulting super-phosphate. The dried tank water has also been tried in the manufacture of cyanide and yellow prussiate sulphate and carbonate of ammonia.

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The Evaporation of Glue in Vacuum Pans.

We have called attention to the necessity of reducing the temperature for cooking glues in time as well as intensity as much as possible in order to obtain the best grades of glue from the raw material in process. It is desirable to draw the liquor from the cookers as fast as produced, reducing thereby the time during which the glue remains in the cooker to a minimum. Bertram in cooking the stock uses a water-bath, preventing thereby the glue liquor as produced to come in contact with steam of a high and dangerous temperature. The process is, however, slow, and what is saved by avoiding an opportunity of the glues coming in contact with the steam of higher temperature, is partly offset by the longer time required for the cooking according to this process. The greatest amount of glue is produced by cooking the well prepared stock with water and steam in open vats, whereby the strength and temperature of the produced glue can be carefully watched. The liquors are run off when showing one to two degrees B. on the glue scale. Such first runs of glue stock, leached bones or horn piths when run in coolers will set and be firm enough to be cut in shreds. Dry glues produced from such jelly are very thin and elastic, requiring a great deal of space in the coolers (4-foot coolers yield from 2 to 3 pounds of dry glue), also in the drying alleys and even in the barrels. A barrel packed with such glue containing but a small weight of same. If the cost of running liquor in thin shreds is higher when calculated per pound of dry glue produced, it is counterbalanced by the high price received for such glue. The last runs from hide stock and all from bones will form a weak jelly not suitable for cutting without causing great loss. It is necessary to have such glue liquors reduced to a consistency so that they will cut and dry as well as the first runs; this is done in evaporators. They are closed apparatus wherein the glue liquor is concentrated at a comparatively low temperature in a vacuum until the required strength is obtained. Even first runs of hide stock are run through these evaporators, if the output is to be increased and the cost per pound reduced; and especially also in summer in order to prevent the glue from running through the netting. Such concentrated glue liquor contains less water, and can therefore be cut in thicker shreds, and even in sheets. When it is desired to give the glue a heavy coloring, the liquor must be concentrated in the evaporator to such a consistency as to keep the coloring matter well suspended in the hot glue. Glue liquors are evaporated up to 20 degrees B. on the glue scale, also a light evaporation up to 8 degrees B. has some advantages. Glues treated with sulphurous acid are losing fame with the progress of evaporation, so that the light yellow glues turn dark brown. Even if not treated with sulphurous acid glue liquors are darkening with the advance of evaporation. This is due to that part of the surface of the heating tube which becomes covered with lime, mineral salts or animal fibrous material, all of them being bad conductors of heat and resulting in the partial scorching of the glue. Lightly evaporated glues allow a separation of foreign matters in the coolers; heavy lime salts will settle to the botom of the glue chunks, and the grease, hair, etc., will rise to the top, from where they can be readily removed, thus giving a better grade, freer from grease and other impurities; the heavily evaporated glues contain a higher percentage of impurities, especially of grease. This statement is undoubtedly correct in most cases; the fact exists, however, not by necessity, but merely by tolerance or ignorance of the ways and means to overcome the disadvantage frequently accompanying heavily evaporated glues. If the glue liquors are properly prepared and handled before they enter the evaporator, they will not only result in just as good a finished article as the non-evaporated glues, but in even a materially better product. All that is required is to free the liquors from impurties, grease, etc., before they enter the evaporator. The weaker the glue liquor, the easier it is to filter and clarify same, to free it of all grease and dirt. The extremely low cost of concentration, as enabled by our best modern multiple-effect evaporators, permits to run the glue liquors from the cookers in such a weak form as to readily give off their impurities, the matters which rise to the top of the liquor (grease, wood, hair, etc.), as well as those that settle to the bottom. Evaporators are now in the market which do the work very economically in regard to the amount of coal used. While one pound of coal will evaporate 2 to 3½ pounds of water in open evaporators under the most favorable circumstances, it will evaporate in a multiple vacuum pan 20 to 32 pounds of water for one pound of coal used. The latest improved evaporators have many advantages. They require a relatively small space; they use exhaustive steam to do the entire work, thus reducing the coal bill to almost nothing; the heating tubes are easily cleaned and replaced, and the loss of glue is reduced to a minimum. Evaporators should be cleaned thoroughly at least once a week, especially the heating tube. This is done with a dilute solution of caustic soda, sulphuric or hydrochloric acid. The last method is, perhaps, the most effective one. It requires, however, great care to avoid any injurious effect of the acid upon parts of the apparatus. No matter what agents have been used for cleaning the pans, same must finally be washed thoroughly with clean hot water.

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The Use of Vacuum Pans For the Concentration of Glue Liquor.

The glue liquors which are to be concentrated in the evaporators can advantageously be drawn from the cookers in such weak, diluted form that even if made from the very best hide stock or leached bones, etc., they would not gelatinize, or at least not set sufficiently to enable the cutting and drying of the jelly coming from such liquors. Such weak glue liquors, we repeat, can readily be clarified, and much better and more completely than liquors concentrated in the cookers alone to a sufficient strength to produce a jelly stiff enough to allow successful cutting and drying. It is therefore not surprising that glue manufacturers making proper use of their evaporator facilities can prepare not only as good, but positively better, and more glue, from a given raw material than those manufacturers who still remain opposed to the use of an evaporator.

We are, however, compelled to admit the existence of a strong prejudice against the use of evaporators for the preparation of very fine grades of glue. Such prejudice lacks, however, a substantial foundation, at least if existing against the use of our best evaporators. These evaporators concentrate the liquor to the desired degree in an extremely short time, the glue liquor remaining scarcely half an hour in the evaporator. As the temperature in the evaporator is a low one, varying from 120° to 180° F. in the different parts of the apparatus, exposing the concentrated liquor only to the lower temperature, it is plain that the liquor produced during one hour's cooking in the cooker, and by a subsequent concentration in the evaporator, cannot become damaged so much as the glue liquor obtained direct from the cooker by longer continued cooking of two, three or more hours' duration.

The proper use of a properly constructed evaporator will therefore produce as light colored, good, clear, pure, strong and even better glues in every respect than can be produced without the use of such evaporator.

We are, however, willing to admit that the use of evaporators has not always been accompanied by such superior results; as a matter of fact, the results produced with evaporators were frequently far from satisfactory. The reason for this must, however, be found either in a careless and faulty manner of utilizing the evaporator, or in a faulty nature of the evaporator, either in the principle or the execution of its construction.

The principal object of the argument advanced is to bring out the possibility of producing as good and better glues with the use of evaporators as without them, and furthermore, to point out the necessity and the possibility to clarify perfectly glue liquors before they enter the evaporator. In this connection we desire to suggest to some enterprising glue manufacturer the trial of a method of clarifying which to our knowledge has not yet been attempted in connection with glue liquors. The different methods of clarifying either by straining and filtering, or by settling with or without the use of chemicals, such as alum or blood, sulphurous acid, etc., have already been comprehensively explained. The methods named have all one or more drawbacks; they are either so slow that the glue liquor is liable to turn sour during the process, or the clarification is not as perfect as desired, or the qualities of the glue become deteriorated. None of the existing glue clarifying methods is really perfect and void of objectionable features. The method which we desire to suggest is based upon the clarifying effect of the centrifugal force which separates within a few minutes and perfectly, matter suspended or floating in a liquid according to their specific gravity. In other words, we recommend a trial with one of the centrifugal machines so commonly in use for the separation of the cream from the milk. [We sincerely believe that an experiment in this direction will pay handsomely, and would be pleased to assist in making such experiment.—The National Provisioner.]

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About Evaporators.

The prejudice against concentrating glue liquors in evaporators is due, as has been pointed out, to the unsatisfactory results obtained with faulty constructed evaporators, or to the carlessness in operating the machines and in handling the glue liquors before and after evaporation. The points which must be observed in preparing the glue liquors for the evaporator have been mentioned. A few words about evaporators will be welcome to those who need and desire information on this matter.

Glue evaporators may be classified in two groups; the first includes all the apparatus in which glue liquors are evaporated under ordinary atmospheric pressure; the second embraces all the machines wherein the liquors are evaporated under a partial or a more or less complete vacuum. The first class includes open steam jacketed kettles of all sizes and shapes, evaporating vats wherein the heating surface is placed in form of steam pipes or coils, stationary or moveable, revolving. It also includes the revolving steam drum type, whether such drum be of a plain cylindrical form, or whether it be provided with flanges and disks or pipe coils, all for the purpose to increase the heating surface in a given space. All of these evaporators, of which a great many forms are possible and have been suggested, and a number of them tried, may have certain advantages for some liquids; for glue liquors each and all of them are unsuitable. We will admit that occasionally these evaporators do fair work, that the results are satisfactory, but we are also confident that better results would be obtained in every case if a more suitable evaporator would be used.

The open evaporators all have the one great disadvantage that the glue liquor must be raised to too high a temperature, in order to effect evaporation. It is not only the temperature of the liquor in itself, but especially the still higher temperature of the heating surfaces which is detrimental to the qualities of the glue. Water will boil at 212° F. at ordinary atmospheric pressure, but glue liquors, especially when they become fairly well concentrated, require a considerably higher temperature. The steam pressure in the heating coils, drums, jackets, etc., must be at least 40 pounds to obtain sufficiently quick results, which would give the heating surface a temperature of about 290° F., which is far too high as to prevent under all circumstances a scorching of the glue, showing itself in a loss of strength or in a detrimental change in the color of the glue. This is especially so when it is desired to concentrate glue liquors to such a degree as to impart to them a sluggish, syrupy consistency; when the glue liquor stops to run freely it is liable to stick to the heating surface of the apparatus and thereby becomes burnt and discolored. Glue liquors which are apt to separate either a flaky or salty sediment, are especially easily damaged in the direction mentioned, due to the fact that the flakes, etc., readily adhere to the heating surface, become heated to a relatively high point, and then decomposed and discolored. This fault all the open evaporators have, whether it be the ordinary jacketed kettle or a box with steam pipes or one of the revolving apparatus modeled after the type of the glycerine evaporator of Leon Droux. Some of these evaporators are so arranged that the liquor to be concentrated remains only a relatively short time in contact with the hot surface, i. e., the liquor passes the apparatus relatively rapidly, entering it on one end, passing the heating surface and being discharged on the opposite end, thus making a continuous evaporator. The evil of exposing the glue liquor to a dangerously high temperature is thereby reduced in time, but it is not done away with. For these reasons open evaporators are not suitable for the concentration of glue liquors. The only method to accomplish this end satisfactorily is to evaporate in vacuo, whereby the evaporating temperature is very materially reduced in intensity and the element of danger decreased in the same ratio.

The concentration of liquors by evaporation is accomplished by raising the temperature of the liquor to a degree at which the vapor-tension of the liquor is equivalent to or exceeding the pressure to which the liquid is exposed. Whenever this degree is reached ebolution begins through the whole mass of the liquid. The degree of temperature to which a liquid has to be heated to boil is therefore a function of the character of the liquid and of the pressure to which the liquid is exposed. The influence of the character of the liquid is fairly well understood. Grain alcohol boils (under same conditions) at a lower temperature than water, wood alcohol at a lower temperature than grain alcohol. Pure water can be evaporated at a lower temperature than water containing, dissolved, a large quantity of salts, or sugar, or glue; the more concentrated the aqueous solution the higher the boiling point. The boiling temperature of a liquid (water in our case) is therefore also influenced by the quality and quantity of the substance dissolved in the liquid. To which extent this influence exists, is demonstrated by the fact that a hide glue solution may be concentrated up to 8° or 12° Baumé, in an ordinary vacuum pan, while bone glue liquor may be concentrated in the same apparatus, under the same conditions, to 22° to 24° Baumé, while tank liquors may be concentrated, under like conditions, to 28°, and even 33° Baumé. The boiling temperature of a solution is therefore influenced by the character of the solvent, as well as by the quantity and quality of the material dissolved in the solvent.

The pressure to which a boiling liquid is exposed consists of the pressure of the vapors as well as of the pressure (weight) of the liquid column itself. The pressure of the vapors will be considered right away. The pressure of the liquid column and its influence are frequently overlooked, though they can be, and are often, of very great importance. The pressure of the liquid column upon each part thereof increases with the depth of any part of the liquid below the surface. The deeper a part of the liquid column is below the surface, the higher the temperature has to be to bring this special part to a "boil." From this statement it might be inferred that the temperature in a boiling liquid varies in its different layers; to a certain extent this is true, but the circulation of the liquid, produced by the heating of same, largely modifies the results. Nevertheless, it is true that whenever the circulation is hampered the fact as stated can be noticed; and furthermore, under all circumstances, good or poor circulation, the fact remains that a shallow layer of liquid can be "brought to a boil" more readily and at a lower temperature than a deep body of liquor. This very important point will be further considered later on.

The influence of the pressure of vapors resting on the boiling liquid is far more conceivable than the influence of the weight of the liquid column itself. If water is heated in an open vessel under normal atmospheric pressure, as indicated by a barometer column of 29.92 inches mercury, the water will boil at 212° F., or at least the vapors, the steam expelled from this water will have this temperature before it has an opportunity to cool off. If water is heated in a vessel partly closed, but provided with an opening through which the outlet of the steam may be controlled; if the vessel is also provided with a steam pressure gauge and a thermometer to determine the temperature of the escaping steam, it will be seen that the temperature of this steam rises with the pressure. To a given pressure the same temperature will correspond (provided there be always a quantity of liquid water). Thus it will be seen that the following temperatures and pressures will always correspond:

Temperature Degrees Fahrenheit.	Pressure above atmosphere in pounds per square inch.
212	0.
213.0	0.3
222.4	3.3
230.5	6.3
237.8	9.3
244.3	12.2
250.3	15.3
255.8	18.3
260.8	21.3
265.6	24.3
270.1	27.3
274.3	30.3
278.3	33.3

An examination of these figures shows that the temperature increases with the pressure, but that the pressure increases faster than the temperature. For each succeeding increase of 3 pounds in the pressure the increase of temperature decreases; the increase of the temperature is 9.4°, 8.1°, 7.3°, 6.5°, 6.0°, 5.5°, 5.0°, 4.8°, 4.5°, 4.2°, 4.0°.

If water is heated in a partly closed vessel and same be provided with an arrangement to exhaust the air and the vapors faster than they are formed, and also be provided with a thermometer and a pressure gauge (vacuum gauge), it will be found that with a diminishing pressure the temperature of the vapors will decrease, and again that to a given pressure the same temperature will always correspond.

Temperature Degrees Fahrenheit.	Pressure below atmosphere in pounds per square inch.
212	0.
209.6	0.7
202.0	2.7
193.2	4.7
183.0	6.7
170.1	8.7
153.1	10.7
126.3	12.7
102.0	13.7

Again, the temperature increases with the pressure, and the increase of the pressure is larger than the temperature, or the decrease of the temperature increases with diminishing pressure; for a decrease of 2 pounds in the pressure starting from near the atmospheric pressure, the decrease in the temperature is 7.6°, 8.8°, 10.2°, 12.9°, 17.0°, 26.8°, and for the last 1 pound 24.3°. With the decreased pressure the temperature at which water boils decreases very rapidly. On this fact and principle the evaporation in vacuo is based; it consists in heating the liquid in a partly closed vessel and in removing the air and the vapors formed in such vessel, thereby reducing the pressure in such a degree as to reduce the boiling temperature to a desired or to a practically obtainable point.

The principle explained above, sufficient to account for the operation of the ordinary old style vacuum pans, does not consider the conditions and circumstances which led to the construction of the so-called multiple effect evaporators. To understand fully the operation of these multiple effect evaporators and their great advantages, it is necessary to examine a few additional facts.

Vacuum evaporators, whether the ordinary old type or the more modern multiple effects, are operated—at least in 99 out of 100 cases—by steam, be same direct steam, coming direct from boiler, or exhaust steam of an engine.

One pound of dry steam of a temperature of 212° F. will heat 5 1-3 pounds of water from 32° F. to 212° F. If dry steam of 212° F. is introduced into 5 1-3 pounds of water of 32° F. as long as all the steam is condensed, or until the water reaches a temperature of 212° F. and the process interrupted at this point, the increase of the water due to the condensed steam will be one pound. The steam has lost none of its "sensible" heat of 212°, but the "latent" heat of the one pound of steam was sufficient to increase the "sensible" heat of 5 1-3 pounds of water from 32° to 212° F.

If dry steam of 20 pounds pressure of a temperature of 258.7° F. is introduced into water of 32° F., each pound of steam will heat 5.42 pounds of water from 32° to 212° F.; the steam in being condensed becomes reduced to a temperature of 212°. If steam of 258.7° F. is employed to evaporate water, i. e., if the steam is condensed in a suitable heating coil surrounded by water of 212° F., and if the in and outlet of the steam to and from the coil are so arranged that only perfectly condensed steam can escape from the coil, it will be found that every pound of steam condensed will evaporate, i. e., transform into steam (of 212° F.) one pound of water of 212° F. This is substantially correct for all evaporators: One pound of steam will, when being completely condensed, give off sufficient latent heat to evaporate one pound of water, provided this water be under so much less pressure that its boiling point be sufficiently below the temperature of the heating steam to bring the water to a boil. The latent heat of the "heating" steam has been transferred to the "created" steam; this latter may become "heating" steam if it is conducted into another heating coil, surrounded by water under a still lower pressure with a correspondingly lower boiling point. To illustrate: If water is heated in a boiler and transformed to steam of 200 pounds pressure and a temperature of 388° F., each pound of this steam if completely condensed in doing so, will evaporate one pound of water of 344° F. and transform it into steam of 110 pounds pressure, which can in its turn evaporate one pound of water of 300° F. and transform it into steam of 55 pounds pressure, which again is able to evaporate and turn into steam of 18 pounds pressure one pound of water of 256° F., capable of evaporating one pound of water of 212° temperature, the steam created still retaining practically all the latent heat which the original steam of 200 pounds pressure and 388° F. possessed.

The economic principle of multiple effect evaporation consists in utilizing the heat introduced into the apparatus as many times over again as there are number of effects in operation. The steam is introduced into the tubes of the first effect, which evaporates about an equal quantity of the water in this effect, and the vapor or steam thus formed passes into the tubes of the second effect, where an equal evaporation takes place, and this vapor passes into the tubes of the third effect, and so on, indefinitely. The circulation of the vapor is maintained by carrying successively higher vacuums (less pressure) on each effect, so that the difference in the boiling points between the liquids in any two effects is about equal to the difference between the temperature of the steam introduced into the tubes of the first effect and the boiling liquid contained therein.

In the old style vacuum pan one pound of steam brought to the apparatus will evaporate one pound water from the liquid contained therein; each pound water evaporated requires for its condensation from 24 to 32 (average about 28 times) pounds cooling water for the maintenance of the vacuum.

In the modern multiple effect evaporators one pound steam brought to the apparatus will evaporate as many pounds water from the liquid as there are number of effects, and the amount of cooling water required for each pound water evaporated is ascertained by dividing 28 pounds by the number of the effects of the apparatus.

The greater the number of effects the greater the economy in steam and cooling water. It might therefore appear advisable to choose a very large number of effects to realize the largest economy; two factors must, however, be taken into consideration, first, that while the number of effects increases the economy it does not increase the capacity of the apparatus, and, second, that practice has demonstrated that three or four effects are usually the largest number of effects which can be combined with satisfactory results. One effect, containing a certain heating surface, will do as much work as four effects of the same size, but the first will require four times as much water and cooling water to attain the same results as the latter. This will readily be understood when it is remembered that the temperature difference of the "heating" steam and the boiling liquid is four times as great in the single effect as in each of the quadruple (four) effects.

One pound of good coal burned under a good boiler and the steam produced utilized for evaporation, will evaporate in an old style vacuum pan 7 to 8 pounds water, in a modern quadruple effect 28 to 32 pounds water.

Of the great variety of vacuum pans invented, recommended and used in practice the greater number have only historical interest; we will consider only a few of the more pronounced types, more for curiosity's sake than anything else. Occasionally second-hand evaporators of this class are offered at low figures on the market. As a rule it can, however, be stated that such evaporators are dear at any price; to build or buy new evaporators of this class is little short of folly.

The old style vacuum pan, usually of more or less spherical shape, though occasionally in form of a vertical or a horizontal cylinder, was ordinarily heated by steam coils, placed in form of spirals in the vacuum pan proper. These coils have great disadvantages; they are frequently so long that the steam is completely condensed before it reaches the end of the coil; the result is that the heating surface is not utilized to best advantage. These coils, whether solidly connected to the pan or not, invariably show a marked tendency to shake and jar, and finally to spring leaks, especially if the liquids are concentrated to a high density. The repairs on such pipe coils are extremely laborious, necessitating frequently the removal of the larger portion of these pipes to permit the leaky pipes to be reached for repairs. These old style vacuum pans have largely given way to improvements, or to what were thought to be improvements. Instead of the pipe coil, two crown sheets are placed in the pan, and these crown sheets connected by vertical tubes of 2 to 3 inch diameter, from 2 to 5 feet long. The heating steam is allowed to enter the space between the crown sheets, surrounding the vertical tubes. This arrangement is not so liable to jar and spring leaks, but if this does occur the repairs are difficult to make. This latter type of evaporator, known as standard vacuum pans, have, with the ordinary vacuum pan, the decided disadvantage that the liquor column in the evaporators must necessarily be relatively high. From 3 to 6 feet liquor is carried in such evaporators, with the result that the boiling point is considerably raised—as shown in a previous article—and that the evolution is frequently very violent, causing mechanical entrainment, i. e., loss of material by the carrying off of solid or liquid particles with the vapors; these particles going with the vapors into the condensers, being there mixed with the cooling water and consequently lost for the purposes for which the liquor is evaporated. This loss through mechanical entrainment can assume very large proportions. It has been demonstrated, especially in the sugar industry, that this loss in some refineries and plantations, has actually reached 20 per cent. and even more. In other industries the loss by entrainment has even been higher; we have a few cases in view where actual tests and the general results proved the loss by entrainment to be nearly 50 per cent. of the material. Manufacturers of vacuum pans have endeavored to diminish the entrainment by making the pipes carrying off the vapors of very large diameter, hoping that by a reduction of the velocity of the vapors in these pipes the liquid particles would have an opportunity to fall back into the pan proper; however, there is little chance for the liquid particles to do this after they have once reached the vapor pipes. This will be evident when it is considered that in a vacuum pan evaporating 2,000 gallons water per hour the rate of travel of the water in a 24-inch vapor pipe is 300 feet per second.

To overcome this entrainment several devices in the shape of catchalls, baffle plates, overflows or separators are occasionally used in improperly constructed vacuum evaporators, and occasionally with the result of reducing the entrainment; but this fact alone is evidence of very faulty construction, and it always remains a matter of doubt of how much of the loss is saved in this manner. All separators or catchalls depend for their action on either having the vapor pursue a tortuous course or impinging on surfaces so as to obstruct the passage of the vapor, and in this way the frictional resistance to the passage of the vapor is enormously increased, which cannot but produce increased pressure or lower vacuum. The separation of the liquor and vapor should take place in the vacuum pan at the surface of the liquid.

The vacuum pans, in spite of their defects, operated fairly well on a variety of liquids as long as they were operated as single effects. When they were combined into double and triple effects their defects were multiplied. The vertical tube apparatus, as well as the spiral coil apparatus, really cannot be operated as a triple effect; the great depth of the liquor increases the heat in each effect to such an extent that the vapor generated in the first effect cannot be condensed in the second; and the capacity of the apparatus is greatly reduced. Usually large amounts of vapors must be pumped out of the coils of the second effect in order to maintain a vacuum in the first, and with a proportionate loss of steam.

Endeavoring to overcome these defects, the so-called film evaporators have been constructed. As the name indicates, the liquid to be evaporated covers—or is supposed to cover—the heating surface in a very thin layer, a film. The film evaporators have overcome the trouble just referred to, but practical working has exposed other defects equally objectionable.

Of these film evaporators, a large variety have been proposed and introduced into practice; few with even satisfactory results. In these film evaporators the liquid runs either on the inside or outside of the heating tubes.

In all of them it has been found to be next to impossible to keep the tube surfaces, whether on the inside or outside, evenly covered with liquid. Where the tubes are vertical, the liquid when running down the inside of the tubes, instead of wetting the entire surface of the tubes, runs down on one side, resulting in a baking or burning of the liquor. When the tubes are horizontal, and the liquid runs through the tubes, only the lower part of the tubes contains liquor, and the burning takes place by the liquor spattering against the top surface of the tubes. Moreover, the escaping vapors must necessarily pass out in contact with the hot upper surface of the heating tubes, thereby absorbing heat which should be used for evaporation. Where the tubes are horizontal, and the liquor runs on the outside of the tubes, the repelling action of the hot tubes on the liquor causes it to have the lower part of the tubes bare.

Of these classes of evaporators, the Wahl pans, the Yaryan, Gaunt and original Lillie evaporators were used for some time; most have, however, made room for more satisfactory evaporators.

Besides the baking and burning of the liquor and the injury done thereby to the final product, these film evaporators have been found to be extremely difficult to clean; the tendency of the liquor to bake causes the tubes to cover rapidly with a scale, which, owing to the form of the tubes, etc., is most difficult to remove. While it has, therefore, been found that these film evaporators may work satisfactorily where a liquor is to be concentrated which is not readily injured by baking, and which has no tendency to form or deposit scale, in a great many cases the users of such machines have found it advisable to discard their film evaporators for other types. In all the film evaporators the liquid is projected violently from the heating surface in the form of spray, which becomes thoroughly intermingled with the escaping vapor, and is very apt to cause serious loss by entrainment; these evaporators are therefore usually provided with catchalls, baffle plates, overflows, etc., the efficiency or service of which we have found to be at least problematical.

The film evaporators are, therefore, not free of a number of great defects. New forms have been devised from time to time, but apparently without producing a material improvement.

The evaporator should cause no loss of the material by entrainment. To meet this requirement there should be a sufficiently large vapor area immediately above the boiling liquid. The travel of the vapor while it still contains liquid particles should be slow. The separation of the liquid and the vaporized portions should take place immediately above the boiling liquid.

The heating surface must always be completely covered with the boiling liquid in order to prevent any baking and burning.

The layer of boiling liquid should be as low as possible, as far as compatible with the previous condition and with the requirements of practical construction. This insures evaporation with the greatest possible ease and economy; the engines and pumps instead of working against a heavy back pressure, either exhaust into a partial vacuum or against a pressure that is scarcely perceptible.

The vapor from one effect must be completely condensed on the heating surface of the next, thus utilizing the heat to the last degree.

The heating surface must be easily get-at-able, and must be so arranged that both sides of the heating tubes can be readily cleaned. The heating surface should consist of tubes of a relatively small diameter; the boiling liquid surrounding the tubes, the steam inside of them.

This arrangement makes the tubes practically self-cleaning.

The heating tubes must be so arranged that it is practically impossible for leaks to occur from expansion or contraction; if, however, a leak should occur, it must be possible to repair same quickly and without disturbing any other tubes but the leaking ones.

The flow of the liquor which is to be concentrated should be a continuous one, i. e., the weak liquor should enter the apparatus at one point, pass through the apparatus and leave it at another point concentrated to the desired density. The weak liquor should have no chance to be mixed with the liquor which has already been concentrated to a certain degree, thus insuring the constant flood and preventing any liquor to remain in the apparatus longer than other portions of it; i. e., to expose it for a longer period to the effect of the heat in the apparatus.

There should be no necessity of pumping the liquor between the effects, nor to pump the liquor from the last effect and return it to the first effect. Once passing through the apparatus must be sufficient to concentrate the liquor to the desired point.

It must be possible and easy to regulate—within reasonable limits—the concentration of the liquor as it is pumped out of the last effect.

These last conditions will allow concentrating the liquor as far as desired while exposing it during a minimum space of time to the effects of the heat.

An essential point in a satisfactory evaporator is that it be provided with means (peep holes) by which the operation of the apparatus can be observed at any time desired. The peep holes should permit the interior of the apparatus to be observed in every part. Without an opportunity to watch the interior of the apparatus the risk of great loss of material is always existing. Evaporators lacking such arrangement have a very serious defect.

The evaporator should be substantially constructed and of material which resists the chemical corroding action of the liquor to be concentrated. The apparatus should not be easily disarranged and gotten out of order. The operation of the evaporator should not require the care and attention of a mechanical genius nor of specially skilled labor. A fairly intelligent workingman should be able to operate such apparatus, producing as good results as attainable.

If all these conditions are fulfilled the evaporator conforms to the reasonable requirements of a satisfactory, safe and reliable modern evaporator.

Of the different evaporators proposed and introduced the Swenson evaporator comes nearest the fulfilment of all the requirements specified. This Swenson evaporator, as manufactured by the Walburn-Swenson Company, of Chicago, does more to overcome the prejudice of the gluemakers against the use of evaporators than all other types of evaporators combined; in fact, the Swenson evaporator is gradually overcoming the prejudice created by the use of such other evaporators. The number of Swenson evaporators sold to the glue trade and the satisfaction which they give fully verify this statement. A short description of the principle and the construction of this Swenson evaporator, which is advertised elsewhere in this work, should, therefore, be welcome to the trade.

Each "effect" of the Swenson evaporator resembles in its outward appearance an immense trunk. The lower ends of the narrow sides of the trunk are provided with a steam chest, which two steam chests are connected with a large number of straight tubes of a relatively small diameter (1¼ in.). This arrangement permits the placing of a large heating surface in the lower part of the said "trunk." The depth occupied by these heating tubes varies from 6 to 12 inches, according to the capacity of the evaporator. Thus is accomplished the desired object of covering the entire heating surface with a shallow layer of the liquid which is to be evaporated. Since the heating tubes connect the two steam chests, the steam introduced in the steam chest at one end of the "trunk" enters the heating tubes, is condensed in same, drains to the steam chest at the other end and is removed either by gravity or pumps. The steam is therefore on the inside of the tubes, the liquid to be evaporated on the outside. This arrangement permits the liquid and the vapors from same to expand freely and regularly; a great advantage over all evaporator systems which confine the liquid in tubes to be heated from the outside. Another advantage of this arrangement is the fact that any incrustation or deposit formed by the liquid on the outside of the tubes cracks readily and has a chance to fall off the tubes. Where the liquid is confined in the tubes and forms a scale, deposit has no opportunity to fall off or to be otherwise removed, except by laborious scraping or chemically dissolving this deposit. Except when used on a few liquids which form a very tough and solid scale, the heating tubes in the Swenson evaporator are practically self-cleaning. For glue liquors, especially, this is a great and important advantage.

To the casual observer it might appear that there is no great difference between the Swenson evaporator and the old type vacuum pan and spiral coils, except in the general shape. As far as the heating surface is concerned it must, however, be borne in mind that in the Swenson evaporator the heating surface consists of a great many tubes of small diameter, all located within 12 to 14 inches of the bottom of the evaporator, while the old style vacuum evaporator is provided with a few (1 to 6) long spiral coils of relatively large diameter, occupying a space of 3 to 4 feet and more above the bottom. The placing of the large number of tubes near the bottom in the Swenson evaporator is made possible by a patented device which permits the fastening of the ends of these tubes in the partition walls between the steam chests and the evaporating chamber proper in a manner which secures a tight solid joint without preventing the free expansion and contraction of the tubes.

The evaporating chamber of the Swenson evaporator in its lower portion is divided in half by a vertical partition, running parallel with the heating tubes and the long sides of the "trunks." This partition extends a few inches above the top row of the heating tubes, and from the one short end of the trunk to with a few inches of the opposite end. The liquor entering the evaporating chamber at the left front end can therefore not leave this chamber through an opening at the right front end without passing over the full length of one-half of the tubes, going around the partition through the opening provided for this purpose.

Thereby a circulation of the liquid is assured which permits the liquid to be evaporated in a continuous stream; for instance, in a triple-effect Swenson where three of the described trunks are combined, the liquor enters the left front end of the first effect, passes around the partition, passed out through a valve into the left front end of the second effect, to go around the partition wall, and the valve at the right front end of the first effect, from there to the left front end of the second effect, around the partition to the right front end of the second effect, and so forth.

This arrangement of the circulation, combined with that of the heating surface, forms the characteristics of the Swenson evaporator; together they produce an evaporator fulfilling all reasonable requirements which may be made of an evaporator. It would lead too far and beyond the limits of this article to enumerate all the advantages and good points of the Swenson evaporator. To see a Swenson evaporator in operation will show more plainly than all the explanations which could be made, why the Swenson evaporator has found so many users and friends. For the concentration of glue liquors, tank water, beef extract liquors, soap lyes, the Swenson evaporator has no superior, no equal. Its simplicity of construction and operation are its most striking features.

It is especially the last point wherein the "Swenson" differs from the numerous evaporators invented and reinvented during the last five years; some of these productions strive to demonstrate how complicated a device may be gotten up to solve a simple problem. A gluemaker thoroughly familiar with the Swenson system cannot learn much from these other devices.

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Glue Tests.

At the request of some of our friends we will give an accurate and complete description of the glue tests, such as used by some of the largest glue manufacturers and consumers, as well as of new tests lately recommended. To obtain a clear insight in the nature of a given sample of glue is a difficult and delicate problem. A perfect and complete glue test is to give positive and reliable indications regarding the adaptability of the glue for the use in the various branches of the trade. One grade of glue will not answer for all purposes. Each consumer of glue requires certain qualities, which cannot all be found combined in any grade of glue. Each trade and each consumer has therefore a very strong inclination to stick to a certain grade, or even a certain make or brand of glue, refusing to experiment with any other kind, no matter how good or how cheap the offered glue may be, if it does not conform in all its qualities to the tried and approved standard.

Chemical tests of glue, such as they exist to-day, are of very little value. Chemical laboratories in general are therefore not places where much information regarding qualities and properties of glue can be obtained; seldom can there be found the apparatus required and men of sufficient practical experience and acquired skill to make satisfactory glue tests. Outside of glue factories very little is known of glue testing. Dealers and consumers have one or two simple tests which they apply to the glue, but as a rule a systematic and complete testing of glues is done only by glue manufacturers, and by few among those. It must be admitted that while we have several good and reliable tests for glue, improvements and new methods are badly wanted. The existing practical tests give no absolute positive results, but only indications of comparative nature, and these only if made by experienced operators under the same conditions of proportions, temperature, etc.

WATER TESTS.

One of the simplest glue tests is the so-called water test, frequently used by glue dealers on account of the ease with which it is made. This test gives a fair idea of the grade of glue in a comparatively short time and without the use of more or less complicated apparatus. The principle of the test is as follows: If pieces of glue of similar thickness are soaked in ice cold water, they will absorb water and swell up. The better the glue the more water it will absorb and the firmer the soaked, swelled up glue will be. The details of the test are these: One ounce of broken glue is put into a glass tumbler and covered with ice water for about twelve hours; at the end thereof the excess of water, the not absorbed portion, is carefully poured off and the soaked glue weighed again. The increase is stated in ounces per pound of dry glue.

A water test of 96 means therefore that one pound of glue has absorbed in twelve hours 96 ounces of ice cold water. The pieces of soaked glue are further examined; they are put to a light pressure between two fingers; the resistance offered to the fingers is noted. Best hide glues and gelatine will take up from 100 to 160 ounces of water per one pound of glue, and the soaked glue will nevertheless be firm. Medium grades of hide glues will show a water test from 20 to 80; the soaked glue will not be very firm. Poor glues absorb but very little water; the soaked glue is soft, occasionally running into a homogeneous jelly. Very poor glues dissolve entirely in ice water. Another important point in the water test is to note the color of the water in which the glue has been soaked for twelve hours. Good glues leave the water colorless, or nearly so; poorer grades give the water a

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color varying from light yellow to dark brown, according to the quality. The odor of the soaked glue permits further very frequently to recognize the raw material from which the glue has been made; hide glue, pig's foot glue, bone glue all show their characteristic odor. The experienced gluemaker and glue tester can further derive a number of other interesting points of information from the water test; the soaked glue will tell him how heavily the jelly was concentrated in the evaporator, how thick the jelly was cut, and will indicate the kind of cutting machine used. Close examination of the edges and surface of the soaked glue reveals this information. This water test fails, however, when applied to heavily evaporated glues, or glues cut in thick sheets. The results obtained with such glues are unreliable and of little comparative value.

TEST FOR "SWEETNESS."

Another important test of glue is the one for the "sweetness" of the article. The principle of this test is as follows: The greater the care taken in the manufacture of glue, the longer the time during which a warm solution of such glue will keep sweet. The number of hours required to turn a glue solution sour indicates the degree of sweetness of this glue. Good grades of hide glue give solutions which keep sweet for 48 to 72 hours at a temperature of from 70° to 80° F. The test for sweetness is made in the following manner: One ounce of glue is soaked and dissolved in four ounces of water. (This same solution can be used for the so-called shot test, which will be described later on.) The glue solution, in a tumbler, is placed in a closed room or closet. The temperature in this closet is maintained between 70° and 80° F. A small amount of steam enters the closet, in order to keep the air saturated with moisture. This latter point is important; it is intended to prevent the glue from drying out on the surface and forming there a hard crust which would entirely exclude the air from the jelly. Thermometers and hygrometers are employed to indicate the temperature and the amount of moisture in the air of the closet. At the required temperature the glue solutions remain liquid. The changes which the glue undergoes are carefully noted. The glue may form a heavy sediment if not clarified properly. Or the glue may show the formation of a light, flaky, reddish sediment due to blood not previously removed from the glue. This is especially apt to occur with bone glues. Some glues turn sour very slowly and will only show a mild sour smell even after 24 hours, and when chilled will form a stiff jelly, while other glues sour quickly, acquire an offensive odor, and will not form a jelly when chilled, such glues being completely decomposed. The test for sweetness can furnish a good many points to judge a sample of glue by. The test is especially important to the glue manufacturer, as it enables him to detect any carelessness or defect in the manufacture.

SHOT TEST.

The consistency of a glue jelly is ascertained by the so-called shot test. This test, in its original form proposed by Lippowitz, is based on the fact that the better a glue the firmer the jelly produced therefrom. The toughness or firmness (consistency) of the jelly is measured by the weight necessary to break the surface of the jelly. Essential in this test is that the glue will completely dissolve in hot water, without forming a heavy sediment, and that the resulting solution will set and form a jelly at a temperature either of 65° or of 32° to 34° F. The details of the test, as proposed by Lippowitz, are these: Five parts of glue are soaked in cold water, and when

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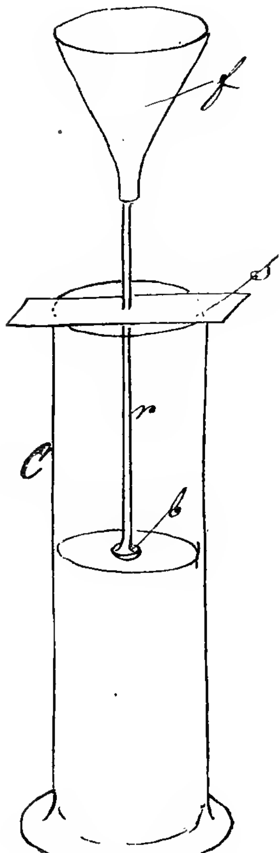

Fig 1.

the glue is softened, sufficient hot water is added that the total resulting solution weighs 50 parts. This solution is allowed to cool and set by standing for 12 hours at a temperature of 65° F. The test proper is made in a very simple apparatus. The jelly has been allowed to set in a relatively narrow, high cylinder C (Fig. 1) (hydrometer jar). On top of the cylinder is placed a light metal strip s, having a perforation in the center. Through this perforation passes the metal rod r, carrying at its lower end the brass button b, on top the funnel f. The rod r is passed through the perforation in the metal strip s, the funnel f is then stuck on top of the rod. The strip s is placed on top of the jar containing the glue jelly; rod r is carefully lowered so that the button b rests on the jelly surface. Fine shot is poured into the funnel f in a steady but slow stream, till the combined weights of rod, button, funnel and shot added are sufficient to break or tear the surface of the glue jelly. These weights give a direct measure for the strength of different glues.

The shot test has been modified in several ways. One of the largest American glue factories uses the following modification: One part of glue (one ounce), broken up into small pieces, is covered in a tumbler with four parts (ounces) of distilled cold water. The glue is allowed to soak for three hours, during which time the contents of the tumbler are frequently stirred with a glass rod, so that the glue and water will form a uniform mixture at the end of the three hours. The tumbler is then placed in a water bath, and the water gradually heated up to 170° F. The glue is stirred several times, and will be dissolved in about ten minutes from the time the temperature of the water in the bath reaches 170° F. Longer heating of the glue solution causes a perceptible evaporation of the water and proportionate concentration of the glue solution, thereby making the test unreliable or valueless. An easy way to overcome this error is to weigh the tumbler with the glue liquor before and after heating, and to add sufficient distilled water to make up for any eventual loss by evaporation. The glue solution, in order to furnish comparable results, should contain exactly 20 per cent. glue. Any foam or even single air bubbles floating on the surface of the glue liquor are carefully removed by a spoon. The glue liquor is then cooled as quickly as possible, taking into consideration, however, that too sudden a change of temperature is likely to crack the tumbler. The glue liquor is quickly cooled by placing the tumbler in an ice box, wherein the air always shows a uniform degree of moisture, i. e., saturation, and where the glue liquor sets to a jelly of smooth, soft and elastic surface. It is very important that the surface of the jelly should not dry out to a hard tough skin. Six hours in the ice box will set the jelly perfectly. The tumbler is then placed in ice water of sufficient depth that it stands on the outside of the tumbler at least as high as the jelly stands on the inside. The jelly is allowed to remain 3 hours in the ice water; during all this time the tumbler is covered to prevent evaporation. The tumbler is then placed on the testing machine (Fig. 2), which consists of the iron plate p, the brass guide rods g^1 and g^2, the sleigh s, which can be moved up and down on the guide ropes. The sleigh s is built of one strip of brass, running from guide rod to guide rod, with two cross bars c^1 and c^2, and bearing an upright brass tube t, which serves as a sleeve for the rod r. Rod r is easily movable in sleeve t; it has a brass button c at its lower end and a funnel f at the upper end. The manipulations of the test are very simple: The tumbler is placed between the two guides g^1 and g^2. The sleigh s is lowered till the crossbars C^1 and C^2 rest on the top edge of the tumbler; the rod r is lowered till the button rests on the surface of the jelly.

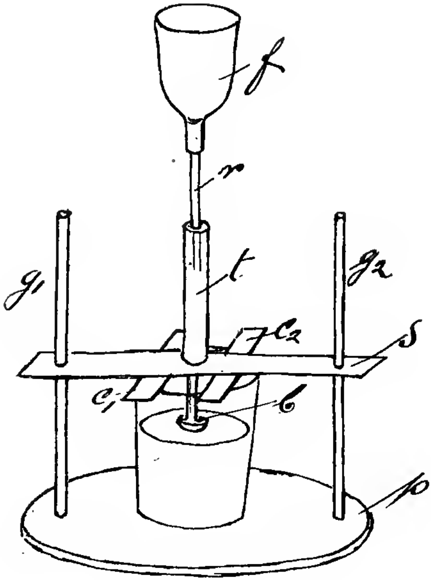

Fig 2.

Fine shot is carefully poured into the funnel in a slow but steady stream until the button breaks the surface of the jelly. The combined weight of the rod r with its attachments (button and funnel) and of the shot added are then ascertained; this weight expressed in ounces gives the "shot test."

The number of ounces necessary to break a 20 per cent. glue jelly varies from almost nothing to 400 and more. With exceedingly strong glues the test is better made on a 10 per cent. glue jelly and the result multiplied by 2. The shot test is a fairly reliable test on glues of light color, and of neutral, or almost neutral reaction. On glues having a strong acid reaction the shot test is of little value.

The results obtained by one and the same shot tests are fairly reliable. Different instruments, of apparently the same make, give, however, widely differing results. The shape and area of the button, the amount of friction of the rod r in the sleeve s, the area of the jelly surface, and, in a measure, the depth of the jelly have all more or less influence on the result. To obtain uniform and really comparable results from the tests made by different persons, results which would be of value to the glue trade and the glue consumer, it would be very desirable to have a standard instrument, of exactly prescribed dimensions and construction.

The shot test gives fairly reliable comparative figures on glues forming jellies, if their solutions are placed in ice water; it is of no value to judge liquid and semi-liquid glues. Excellent qualities of liquid glues are put on the market, glues surpassing everything known in adhesive power, binding quality. To test such glues, and, in fact, all glues, whether forming stiff jellies or not, the viscosity test is the most suitable.

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The Manufacture of Pig's Foot Glue.

Pig's foot glue, as indicated by the name, is made from pig's feet, which, however, are at times partly replaced by heads, ears, tails and skins of pigs. The glue made from the mixed material is inferior to the product obtained from feet exclusively. The American pig's foot glue is put on the market in form of thin shreds, either not colored (resembling gelatine) or colored with zinc white and broken up in large pieces. The trade does not like finely crushed pig's foot glue. It must be admitted that the finely crushed pig's foot glue is usually inferior in quality, indicating that proper care was lacking at some stage of the manufacture.

The manufacture of pig's foot glue has been considered a trade secret for many years. Only a few glue factories were putting a satisfactory article on the market. Of late years the number of glue factories producing pig's foot glue is increasing. The demand and prices for a good looking pig's foot glue have steadily been good; the inducements to take up the manufacture of this grade of glue were consequently tempting.

The first condition for producing nice pig's foot glue is to secure the raw material in perfectly sound condition. This is only possible if the glue factory is in close proximity to a hog killing or packing establishment, or if the weather or artificial refrigeration permit the safe transportation of the pig's feet to the glue factory. Antiseptic treatment of the pig's feet at the slaughter house will eventually prepare them for safe transportation of longer distances. The largest supply of pig's feet is, of course, during the cold season, the season of glue making.

The pig's feet entering the glue factory must undergo a thorough washing process. All manure, blood, etc., must be completely removed. The cleansed feet are covered with an aqueous solution of sulphurous acid. The feet with this acid solution are kept in a slow motion for 12 hours. At the end of this time the acid is nearly consumed; very little odor of sulphurous acid can be noticed. The feet are starting to swell. The liquor is run off, and a fresh lot of aqueous solution of sulphurous acid is allowed to cover the feet a second time. Feet and acid are again kept moving slowly, this time for 24 hours, after which the liquor is again run off, and the feet removed to the cooker. The feet smell now very strongly of sulphurous acid; they are swelled up to double their original size, and have assumed a semi-transparent appearance. The swelling of the feet, due to the absorption of a large amount of water, makes it necessary that the vessel in which the feet are treated with sulphurous acid should only be filled a little more than half.

In the cooker the feet are covered with clean water. After standing for three to four hours the water is run off, fresh water put on the feet, and cooked with same. Great care is necessary in the cooking process, especially in the starting of a cooker. There should be 6 to 12 inches space to allow the feet to sink. The steam must be turned on slowly. The temperature should rise gradually, and be as uniform as possible through the entire mass. The thermometer should not register more than 180 degrees F., or maximum, 185 degrees. This is absolutely necessary to obtain colorless and clear liquors, as well as good and clear lard. After heating for four or five hours, the liquor shows a strength of 2 degrees Baumé, measured hot. The steam is then shut off. The liquor is allowed to settle for half an hour. It is not advisable to allow the liquor to stand any longer in settling, as it is very likely to assume a yellow color. The lard is run off and skimmed off as thoroughly as possible. The liquor is now run off slowly and collected in a large re-

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ceiving vat; it shows a temperature of about 165 degrees F., and about 3 to 4 degrees on the glue scale. The liquor should be clear and water white; it should not be strong in acid, as indicated by the litmus test. An excess of acid prevents the liquor from holding the coloring matter, zinc white, in proper suspension. Such glues, after being dried, have neither the appearance of a colored nor of an uncolored glue. The gluemaker says, the color dried out.

If it happens that a liquor is strong in acid, or that it appears cloudy, milky, not settled, then old milk of lime, or, better still, milk of magnesia, is added to the liquor and thoroughly intermixed by stirring. The lime or magnesia not only neutralizes the excess of acid; they also bring about the formation of insoluble phosphates, which in settling to the bottom of the receiver, envelop, or at least carry with them, all the undesirable suspended particles. The temperature of the glue liquor should not exceed 140° F. when lime or magnesia is added. The grease should also be previously removed; otherwise the liquor does not clarify properly. To some extent a weak solution of ammonia can be used in place of the milk of lime. After two hours of rest the glue liquor is perfectly clear; the lime has formed a heavy sediment. The clear liquor is allowed to run to the coolers, either in the now clear condition, or after being slightly colored with zinc, etc. The clear liquor, after cutting and drying, resembles very much ordinary gelatine. Frequently the clear liquors are concentrated in a suitable vacuum evaporator, raising thereby the density to 8° Bé. This concentrated liquor is colored and run in coolers. The coloring material usually employed is finely ground zinc white, either of French or domestic manufacture. The zinc white is usually added in form of dry powder. It is preferable to add the zinc white in form of a thin paste, prepared by grinding some zinc white with water. Zinc white in this form goes furthest in coloring power. French zinc white is higher in price than the domestic article, but gives the best results. The jelly after properly setting in the cooler, should be cut with wire machines only, if the desired gloss, smooth and bright, is to be obtained. The drying process should be conducted at a comparatively low temperature, in order to preserve the good appearance of the glue. The dry shreds are crushed and packed in large size barrels. The second run of glue liquor off the pig's feet, which should be prepared and handled in the same manner as the first run, gives a product of yellowish color. Occasionally the first and second runs are united and handled together.

The last runs off the pig's feet furnish "bone" glue. Acid is used in the cooking; the temperature in the cooker is raised to 212° F.

The sulphuric acid used in this process should be frequently tested; its density should not exceed 1° Baumé (cold) and should be free of an excess of sulphuric acid; the latter frequently is the primary cause of the rough surface produced on the glue by the formation of crystals of sulphate of lime.

Coloring the glue liquors with zinc white requires practice and experience. It is frequently difficult to strike the right proportion to produce a glue sufficiently colored without adding too much zinc white, and producing a "dead" white.

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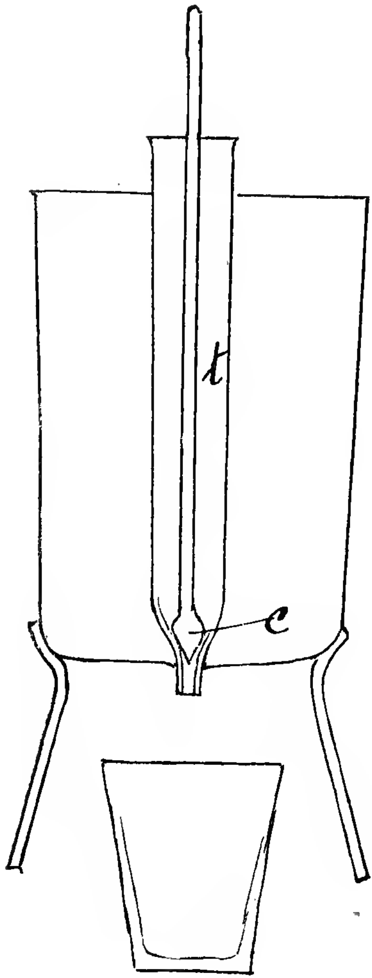

Fig 3.

The Body Test.

The body test, or, viscosity test, is based on the assumption that the better the glue, the thicker and heavier its solution of equal strength and temperature, the greater its viscosity. This body test can be carried out in a great many different manners, but to obtain comparable results it is necessary that the tests should be made under like conditions. The method and apparatus used by one of the largest American glue manufacturers recommends itself by its simplicity. The 20 per cent. solution of glue —same as used in the shot test previously described—is poured into a glass tube t (Fig. 3) of 12 to 15 inches in length and about 1 inch in diameter. The tube is drawn out at the lower end to an opening of exactly 1-12 inch in diameter. This opening may be tightly closed by the glass rod with the ground stopper c at the lower end. The tube is placed upright in a water-bath of 167° F. Five ounces of glue liquor (20 per cent.) are poured into the tube and allowed to remain in the tube (covered) till the glue liquor has a temperature of 165° F. The stopper c is then raised and the 5 ounces of glue liquor are allowed to run out of the tube; the time necessary for this is accurately determined and furnishes a measure for the viscosity of the glue liquor. A comparative test is made with distilled water of 167° F. It shall take, for instance, 40 seconds for 5 ounces of water to run out of the tube; 5 ounces glue liquor will require in the same apparatus from 41 to 100 seconds, depending upon the quality of the glue. The viscosity is properly expressed in per cents. of the water test. A 20 per cent. solution of same grade of glue shall require 62 seconds; its viscosity would then be 62x100, or equal to 155 per cent.

Shot test and body test usually give uniform results; glues of strong acidity make an exception; they show frequently a low body test with a high shot test; alkaline and neutral glues usually give well agreeing results in the shot test and the body test.

In making the body test, great care must be taken that the fine opening of the glass tube is kept scrupulously clean and is heated to the temperature of 167° F. The apparatus described and illustrated in Fig. 3 is very simple, but has a number of serious defects; the results obtained with it, in order to be comparable, must really be obtained with one and the same instrument; for factory tests the apparatus may therefore suffice, but hardly for commercial tests.

A viscosimeter of slightly more complicated construction, but of easier operation and furnishing more accurate results, is illustrated in Fig. 4 in the form recommended by Reischauer-Aubry; it consists of a pipette-like glass tube placed in hot water. The pipette is made of two pieces; the tube A with cone C and extension F, and the large tube B drawn down to tube E. Cone C forms a ground-in stopper to the tube B. The tube E is drawn together at D and bored so that the opening there is exactly one-twelfth inch in diameter. The inside diameter of tube E should be one-quarter inch. The lower end of tube A F when placed in tube B should be 1 inch above the opening D, tube E should extend two inches below point D. To operate this viscosimeter, the end of tube E is closed with a small rubber stopper, or rubber tubing and glass rod. The pipette is filled with the glue liquor, and placed in water of 167° F. When the glue liquor has been heated to 167° F. tube A is closed by pressing on it the end of a finger, the rubber tube or rubber stopper is removed from the end of tube E; a measuring flask, holding 100 cubic centimeters, is placed under tube E; tube A is opened, the glue liquor begins to run through opening D; the time required to fill the 100 cc. flask furnishes again the measure of viscosity, or

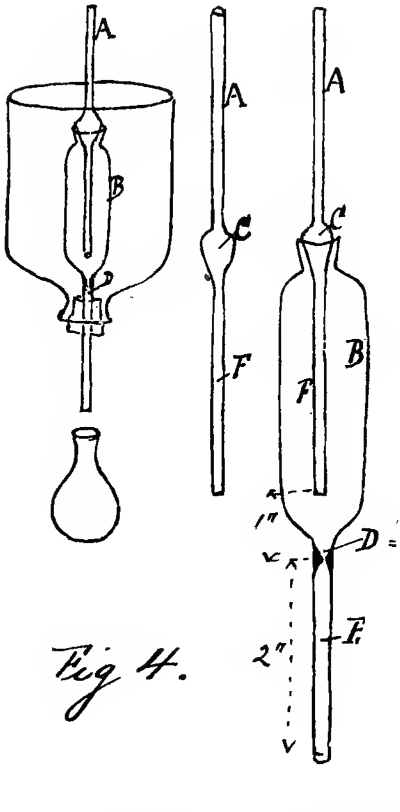

Fig 4.

the body test. This viscosimeter, with the first one described, has the drawback that it is difficult to produce two of these instruments with the essential parts exactly alike. Numerous other viscosimeters have been proposed and brought into use; of these a few have been accepted as standard instruments; their general use for commercial glue tests would mark a decided progress.

Spandau Test and Other Tests for Adhesive Strength.

For all purposes where glue and its adhesive properties are used to join together materials of like, similar or different nature, a test which would permit to measure these adhesive properties must be most welcome. The greatest portion of glue manufactured is probably used in joining wood to wood. Furniture and piano factories, railroad car shops, carriage and wagon builders use immense quantities of glue for this purpose. The importance of being able to ascertain with at least approximate correctness the adhesive strength of different glues is apparent to these trades.

Several modifications of this most important glue test have been proposed. Wood was first exclusively used for testing the adhesive strength, principally hard wood, such as maple, oak and birch. The difficulty of securing always wood of uniform grain, dryness, etc., has induced the trial and use of metals for this purpose. Whatever the modifications may be, they are all based on the principle first proposed at the Royal Artillery shops at Spandau (Prussia), which gave the following directions:

SPANDAU TEST.

Three parts of glue (but not less than 250 grammes) are mixed with parts of water and boiled in a water-bath till the weight of the mixture is only five-ninths of the original mixture. Two-thirds of the originally added amount of water have been evaporated; this is prescribed and done to test the glue after six hours' heating in a water-bath, such as happens in the practical use of the glue. The glue boiled in this manner is now used for the test proper, which is applied on hard wood and soft wood. Square strips of wood are cut 420 mm. long, 40 mm. wide by 40 mm. high. These strips are cut in two, making strips each 210 mm. long. The two pieces belonging to-

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gether, resulting from the cutting of a piece 420 mm. long, are glued together on the cross-cut surfaces. In this manner the two pieces joined together are as nearly alike on the grain as can be obtained.

The wooden strips reunited by the glue are allowed to remain for 72 hours in a dry room at a temperature of about 70° F. The one strip is then fastened on a table with clamps, so that the glued joint sticks 10 mm. over the edge of the table. The other strip is provided with a hole 180 mm. from the joint; a bolt passes through this hole carrying a scale to receive weights. At first 25 kilograms are placed on the scale; every minute additional 5 kilograms are placed on the scale, till the joint breaks. Four tests, two each with soft and hard wood, are made. A good glue should stand at least the weight of 70 kilograms.

A similar test, more empirical, requiring less time, but not so accurate in its results, is in use among American gluemakers and dealers. This test is made as follows: One part glue (not less than one-half pound) is soaked in 3 parts water for three hours, then heated in the glue pot till one part of the water has been evaporated, leaving a 33 1-3 per cent. glue solution in the pot. The glue, frequently stirred, is kept hot, to be as fluid as possible and to fill the pores of the woods to be joined for the test. Two pieces of hard wood are planed off so as to make them fit together perfectly. The smooth surfaces are slightly warmed, the hot glue applied on both surfaces. The pieces are then pressed together, and by careful pressing and rubbing the surplus of glue is pressed from between the two pieces. When this is done and the pieces are in exactly fitting position, they are placed between carpenters' clamps, which are screwed together tightly without imparting to the test pieces any lateral motion; the whole is allowed to remain over night in a moderately warm room. On the following morning the clamps are removed. A saw is used to make a small cut in the joint. Chisel and hammer are then used to split the two pieces of wood along the joint. In such efforts the chisel driven into the joint may split same readily, leaving the surfaces of both pieces smooth, probably with some dry glue on either surface. Such glue makes very poor joints, and is to be rejected for wood joining purposes. Or the chisel must be forced with considerable power to break the joint. The surface shows that some parts of the surface of one block of wood are covered with pieces of the other block; other parts of the surface, where the glue had little effect, are smooth. Such glue is of good

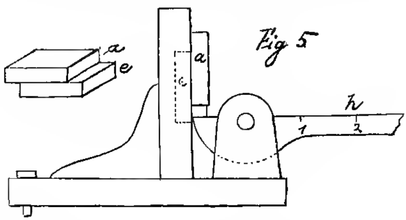

Fig 5

quality. Or it may be very difficult to drive the chisel into the joint. When a split finally is produced, the surfaces being very uneven, like those produced by chopping with a dull hatchet, the joint has really not been broken in the glued line, but rather in the wood itself; such glue is of very great adhesive quality.

This glue test seems to be simple enough. It requires, however, experience and skill, and repeated tests to obtain reliable results. These results, unlike those of the Spandau tests, cannot be summarized in comparative figures.

The glue testing apparatus of G. Falter permits comparative figures to be obtained on substantially the principle referred to above. This apparatus consists of an upright casting containing an empty space, into which one of the test blocks of wood fits accurately. Fig. 5 shows the apparatus. The test blocks a and e are shown separately and in position in the tester.

The lever h permits the application of pressure, varying between 50 and 2,500 pounds, upon the joint of the two wooden blocks. These wooden blocks (preferably beech) are rubbed down with glass paper to be perfectly level and smooth. They are glued together, the grain running in the same direction, but so that the one block c protrudes 1 centimeter. The blocks are about 4 centimeters square and 1 centimeter thick. The glued pieces are clamped together and allowed to remain so for three days, when they are subjected to the test.

The use of wooden blocks or sticks for adhesive tests has the one serious difficulty that it is impossible to obtain a uniform material for these tests. Consequently other materials have been proposed and tried; metals which obtained with relatively small difficulty may be of a uniform grain and surface. Metals have further the advantage that the same test blocks can be used for testing almost any number of glue samples, while each pair of wooden blocks can only be used for testing one sample. At the outset it was doubtful if the adhesive strengths of different glues would have the same relations, whether tested in joining wood or in joining metals, such as steel or nickeled steel. Tests have, however, demonstrated that these relations vary very much in the same manner, whether the glue be applied to wood or iron.

F. M. Horn first proposed the use of steel surfaces to test the adhesive power of glue. The apparatus is illustrated in Fig. 6. The lower part consists of a steel cylinder A, having on its upper surface a hole bored 44 mm. in diameter and about 12 mm. deep, and its lower end provided with a loop B to carry a scale with weights. The

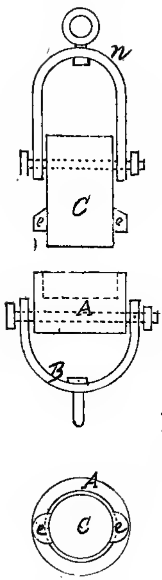

Fig. 6

upper part consists of a solid cylinder C, 33 mm. in diameter, provided with lugs e, to prevent C from getting too close to the bottom of the bore in A, thus insuring always an equal distance between A and C. The upper cylinder has a loop n, allowing the cylinder to be suspended. Both loops B and n can be detached from the steel cylinders. The entire apparatus is nickel plated to prevent the rusting of same, in spite of frequent cleaning with warm water.

To make the test, the glue is soaked in water between 2 and 6 hours, and then dissolved in hot water to make a solution of 1 part glue and 1 part water; 5 cc. of this solution are brought into the bore of cylinder A, which is sufficient to fill the space between cylinders A and C. The latter is dipped into the liquid glue, and the entire apparatus now allowed to stand for 12 hours at a temperature of about 60° F. The weight is then ascertained, which is required to break the joint. Of course, it is necessary to make these tests always under substantially the same conditions. The weights required to break the joint are, for poor glues, between one-half and three kilograms; for good cabinet glues, 3½ to 10 kilograms; for cobgne glues, about 10½ kilograms.

R. Kissling, following Horn's proposition, adopted a similar nickel plated iron apparatus for testing the adhesive strength of glues. Figs. 7, 8 and 9 illustrate this apparatus (one-half original size). It consists of two solid cylinders, A and B. Cylinder A has a slightly convex surface at a, cylinder B a slightly concave surface at b; these surfaces are carefully ground upon each other; the area of each surface is 1.8 gcm.

The test is made with a solution of 1 part glue in 2 parts water. This solution is heated on a water-bath, as are also the two cylinders. The concave end of cylinder

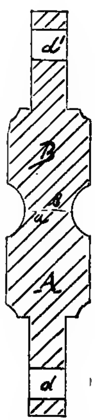

Fig 7

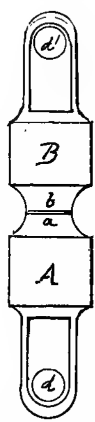

Fig 8

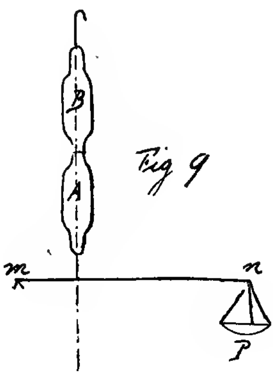

Fig 9

B is dipped in the glue solution and fastened in a suitable support with the concave end pointing upward. The convex end of cylinder A is then dipped in the glue solution. The glue solution on the two ends, a and b, is rubbed till nearly dry, which requires but a fraction of a minute. Then the two ends are pressed together and held together with a weight of 5 kilograms, which is allowed to remain over night. Next morning the weight is ascertained which is required to tear apart the two cylinders.

The principle of the apparatus used for this purpose is illustrated in Fig. 9.

Kissling admits that this apparatus does not always give uniform results. Horn's apparatus should give better results. Kissling, in the maner in which he coats the testing surfaces with glue, leaves room for considerable difference; it is evident that the rubbing of "the ends till nearly dry" cannot result in always getting the same amount of glue between the testing surfaces. Horn's apparatus is better on this score. But even Horn's apparatus at times gives results which are not entirely satisfactory. These tests for adhesive strength, desirable as they are or might be, are not used so frequently as the interests of the glue consumer and glue manufacturer would justify.

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Foaming Test of Glue.

For certain purposes, especially for veneerings, and more so when revolving brushes are used to apply the glue solution for this purpose, foaming glues cannot be used, as the joints will split and the veneer separate from the underlying material.

To test the glue for foaming quality, a hot 20 per cent. solution of glue is stirred for one minute with an egg beater or a glass bar; the foam produced is watched for five seconds; if the foam disappears in this time the glue is pronounced not foaming. If the foam remains the height of same is measured in inches. Glues made of not properly washed stock, and even bone glues, especially if treated with sulphurous acid or colored strongly with zinc white, will foam up to 1½ inches. To make accurate comparative foaming tests of two or more grades of glue, the double-headed "milk-shake" machine gives very reliable results.

CHEMICAL TESTS FOR GLUE.

Of the great many chemical tests proposed for the examination, a few are constantly used by practical glue makers.

Among the chemical tests, the one by the tongue of a practical glueman is not the least important one. Allowing a small piece of glue to dissolve on the tongue, the expert will be able to tell the reaction of the glue, when it is of pronounced character. The expert will readily recognize sulphurous acid, if such has been used in the preparation of the glue without great efforts to remove all of the sulphurous acid. The nature of the raw material can frequently be recognized by the tongue test. But, after all, the tongue test is not very reliable, no more than the test by smelling the glue. If a piece of glue is moistened and then rubbed hard with the palm of the hand, or with a cloth, the characteristic smell of the glue becomes much more pronounced.

The odor of the glue becomes still more pronounced when a hot solution containing 20 per cent. glue is prepared. The expert can detect in the odor of such solution the origin of the glue, bullock, sheep, pig, fish, country bones, fleshings, especially horse fleshings, hide stock, rawhide, alumed stock, harnessmaker's stock, sulphurous acid, overlimed stock, green stock, etc.

The litmus test will tell the reaction of the glue much more accurately than any tongue test. It is essential to use a very sensitive litmus paper; the ordinary grade of commerce is not sufficiently sensitive. For this reaction test, a solution of glue is prepared and tested by dipping into it litmus paper. If red litmus paper is turned blue, an alkaline reaction is demonstrated, caused, for instance, by presence of caustic lime. If blue litmus paper turns red, the glue has an acid reaction.

For many trades it is essential that the glue used be free of grease. It is not important to know how much grease is present, but rather to know that there is no grease at all present in the glue. The practical test for grease in glue is very simple and reliable. Three or four tablespoonfuls of a 20 per cent. glue solution are put into a tumbler and colored heavily with either lampblack, zinc white or Turkey red. The glue is kept hot by placing the tumbler in hot water, and is stirred up with a glass rod. With a perfectly clean brush the even mixture of glue and coloring pigment is applied on white wall paper. The brush is pressed slightly on the paper and moved slowly over it, without passing twice over the same spot. If the glue is free of grease a uniformly colored stripe will be seen. If the glue contains traces of grease dark round spots will be noticed here and there in the stripe, the number of such dark spots increasing with the amount

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of grease present in the glue. Glues containing grease cannot be used in the wall paper trade. It is astonishing how scarce glues are which are really free of grease. European glues, so well liked in match factories, are seldom free of grease, though it is claimed that glues containing grease will not mix with phosphorus.

ANALYTICAL.

Of actual chemical tests, two are only recognized as of importance by some gluemakers, namely, the test for moisture by drying powdered glue at a temperature of 212° F.; the moisture varies from 6 to 15 per cent. in the different grades of air-dry glues, and, second, the test for salts and impurities of an organic nature. This test is made by igniting glue in a platinum crucible until the ashes are perfectly white, or as nearly so as possible to obtain same. The inorganic impurities vary from 1 per cent., found in gelatines, to 25 per cent., and more found in heavily colored Russian glues. A fair average amount of ash in hide glues is 5 to 6 per cent.

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About Isinglass.

Under the designation isinglass, it is understood as a substance of animal or vegetable origin, containing a certain amount of raw or pure gelatine, and thereby specially adapted for the clarification of all kinds of liquors, particularly of wine and beer. The main result of the application of natural or prepared isinglass is that a solution of same, poured carefully on the liquor to be clarified, forms on top of the liquor a fine net in the form of a thin layer, which sinks slowly down through the liquor, enclosing all suspended matter, such as albumen, fiber, etc., leaving the top liquor itself in a perfectly clear condition. This process of clarifying is in most cases due to mechanical action, but if liquors contain tannic acid, the process is partly a chemical combination of gelatine and tannic acid, the new formed product enclosing and carrying down with it suspended impurities. According to the mechanical condition of the liquor to be clarified, it requires from seven to fourteen days to accomplish the desired result. The most preferred forms of isinglass are the Russian, Indian and South American, all being made from bladders of certain kinds of fish. Washing and bleaching with sulphurous acid, cutting and drying constitutes the entire process of recovering the isinglass from these fish bladders. Fish isinglass dissolves very slowly in water, and it is necessary to use tartaric or citric acid to hasten the solution. The high price of these goods induced the search for substitutes which would accomplish the same work for less money; it was found that gelatine cooked at a low temperature would best answer the purpose. Of course, it was necessary to use the finest raw material and the greatest care in the manufacture of this substitute.

Artificial isinglass, as we may call this product, dissolves readily in warm water, after being soaked in cold water for about an hour. It is furthermore a fact that alkaline or neutral gelatine does not clarify well, while gelatine showing an acid reaction with blue litmus paper gives excellent results. One pound of isinglass can clarify up to 150 bbls. of beer. Every brewer used to consider his method of applying isinglass a valuable trade secret. Some clarified cold, some warm, some hot, and each claimed to get the best results. The best raw materials for making artificial isinglass are calf heads (skin). They are subjected to a process of washing and treating with sulphurous acid. Ater three weeks the heads are swelled up to double their size, and are of a clean, white color on the inside and can easily be torn apart. The heads thus treated are cut into small pieces and transformed into gelatine by dissolving same in water of a temperature of 160° F.

Isinglass has been used in immense quantities for the clarification of beer, but since the introduction of filters, which do the same work very economically and in a very short time, isinglass has come to be a rare article in breweries.

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About Raw Material For Making Gelatine.

Gelatine is a glue of the finest quality and of the highest strength, being at the same time perfectly odorless and colorless and containing but a very small percentage of mineral salts. The purity of the gelatine makes it necessary to select the raw material very carefully, and to use the greatest care in preparing and curing same. We can state emphatically that it is the curing of the raw material alone which results in a product of superior or inferior quality. There is, principally, but two kinds of raw material which can advantageously be worked into gelatine, and they are:

First—Hard shank bones; second, horn piths. By hard shank bones we understand round shins, flat shins, buttocks, shoulders, thigh and blade bones.

These bones must be free of all grease before they are worked into gelatine, which is accomplished in two ways; either by the benzine process, which is largely used in Europe, or by cooking the bones a short time, which is principally used in the United States. Although the benzine process turns out bones containing only one-tenth per cent. of fat, it has not come into general use in the United States, in spite of the fact that cooked bones contain always 1½ per cent. or more fat. The principal reason why the benzine process has not been adopted is the low-grade quality of the fat produced and the danger of the process in itself, in regard to fire, explosion, etc., but this last point has been largely overcome in the last few years. The hard shank bones are, so far, the best material. From the bulk of the bones in the market, under some conditions, shoulder blades, jawbones and some other bones could replace the costly shank bones. The nature of shank bones requires a separate cooking of them for different lengths of time. Before they are cooked they go to the sawyer, who cuts off the caps, in order to open the bones on both ends and allow the fat to cook out as completely as possible. The bones are then put in cold water, which is frequently changed until the bones have a perfectly white appearance. Blood is extracted easier and more completely with cold water than with warm water. It is necessary to have all the blood completely removed, as it would cause a great deal of trouble later on by coloring the gelatine and making it extremely difficult to clarify same. The rule for cooking shank bones is to continue it long enough so that the meaty fiber becomes loose and can easily be removed. If the fiber remains with the bones it will produce milky liquors. Round or flat shinbones require from three to four hours' cooking; thigh bones about seven hours; the rest of the bones, buttocks, shoulder blades, about eight hours. The marrow of these bones can either be taken out or left in the bones for cooking, as a different treatment affects the grease only, and not the bones. After being properly cooked and the glue liquor being drawn off, the bones are washed several times with warm water, to allow the last particles of grease and meat fiber to be removed. Hot water for washing bones is absolutely necessary, as greasy bones are not wanted; they get a rancid smell, especially if stored dry for any length of time. The best way is to use as much of the bones as possible in fresh condition, and to dry them only sufficiently that they may be broken in smaller pieces with a crusher. The pieces shall not be too fine and not too coarse, in order to avoid waste of bones or waste of time in the leaching process. The crushed bones are put in wooden vessels and covered with a dilute solution of muriatic acid or phosphoric acid.

Second—The horn piths are the finest and richest material for preparing gelatine. In buying horn piths a few points must be observed: Horn piths should, if possible, be dried by open air drying. Drying on coils is liable to partly destroy the glue, or at least discolor it. The hair and skin should be removed from the pith, and it should have a white and smooth appearance. This is of great importance, as hair and skin are acid consumers, and become totally destroyed and dissolved in the acid and give a dark color and strong smell to the remaining gelatine. Besides it is impossible to free the pith from the blood if the skin is not removed, and it is, therefore, advisable to have the pith, after being slugged, cooked from about one-half to one hour, thereby loosening the skin. If the skins are then removed and blood properly washed out, and the horn pith dried at a moderate temperature, they will show a nice, white, clear color. Occasionally pieces of fat may adhere to the hard surface, which is due to careless sawing off, and in cooking such pith the grease will give the gelatine a rancid smell. The properly prepared piths are crushed into coarse pieces and submerged in a weak solution of muriatic or phosphoric acid. This muriatic acid should be about 2° B.; phosphoric acid of 6° to 8° B. is not too strong.

Cooking of Gelatine.

The green raw gelatine or leached bones and horn piths still contain a considerable amount of acid, even after receiving a thorough washing, and the quantity of acid present would be sufficient to turn out low grades of gelatine. Raw gelatine, furthermore, has a very peculiar smell, very similar to that of rancid tallow. The strength of this odor varies with the quantity of grease present in the bones as leached.

Bones treated with benzine, by which process the percentage of grease has been reduced to 0.1 per cent., show hardly any of this rancid smell. For these reasons the green raw gelatine cannot be directly converted into gelatine proper. The acid and smell are best neutralized by placing the raw gelatine into fresh milk or lime, and keeping it there for three days under constant stirring. This is easiest accomplished in washing mills, wherein the raw gelatine requires no more handling or attention until the acid and smell are removed. The limed raw gelatine is then washed until the lime is entirely removed, and the material shows a nice, clean, white appearance and a mild, agreeable smell of limed glue stock. The material is then further treated with a weak solution of sulphurous acid in water until the raw gelatine becomes transparent and the odor of sulphurous acid becomes plainly noticeable. The material thus prepared receives a final washing with clean water, and is then ready to be transferred into the cooker. In hot weather and when it is not possible to cook the material immediately, the washed and limed raw gelatine is pressed, dried and stored away in a dry and airy place, and undergoes the same treatment as green limed raw gelatine before going in the cooker. Properly prepared, raw gelatine requires only boiling hot water, without any additional steam in the cookers. Live steam of high pressure is liable to discolor the gelatine. Water used for cooking must be free from salt; distilled water is preferable. The material dissolves rapidly in hot water of 180° F. Six to eight runs are made from one lot of prepared gelatine, according to the amount filled into the cooker. The liquors first drawn off are naturally the best and clearest, and are kept separate from the subsequent runs. After remaining undisturbed in the cooker for about a half hour the liquor is run off slowly, so as to obtain it as clear as possible; it should show then about 1° B. on the glue. A sample is drawn and put in a small dish in a cool place. The resulting jelly must be perfectly clear, odorless and colorless. It must be firm and should not break easily. Occasionally a little coloring with aniline blue is necessary to neutralize the yellow shade. If the gelatine liquors are not quite clear, as is frequently the case with the last runs, it is necessary to clarify same with blood or albumen. The clarified liquor has to settle for twelve hours, and will produce a very nice, but somewhat foaming, gelatine. The liquors are run into the cookers without any previous evaporation in the vacuum pan. As gelatine shreds must be as thin as possible, the liquor should rather be kept below 1° B. than above. It is not necessary to add that everything should be kept scrupulously clean, from the cookers down to the packing of the dry gelatine sheets. This gelatine must be of nice, glossy appearance; six sheets laid together should not show any yellow color, and in solution it must be perfectly tasteless and odorless. One pound of gelatine should take up sixteen pounds of water, and the jelly produced must be firm. Good gelatine does not dissolve when placed in ice cold water. It is preferable to dry gelatine on clean cotton nettings, as zinc nettings, even if new ones are used, could be injurious to the health of the consumer.

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How to Economize Acid in Leaching Bones for the Manufacture of Gelatine.

If sound, hard bones are leached they require equal parts of strongest muriatic acid of 22° B.; of weaker acids they require proportionately more. Horn piths require about 10 per cent. less acid than bones. Hard bones and sound horn piths seldom show a loss of acid, as the weak acid penetrates the material easily; but it is different with overcooked bones or burnt horn piths; these become soft in the acid in a very short time, as they contain no substance to hold the raw material together when the organic substance has been destroyed, either by prolonged cooking or heating. Such material becomes very smeary in the leaching vats and forms a solid mass, stopping the process entirely. In working such material there is finally nothing left but a few hard, untouched bones, as the acid and the gelatine have been washed off entirely. This is naturally a very serious loss, and will not occur if the quality of the raw material has been properly tested. Another serious loss of acid can occur from leaking vats and faucets.

As mentioned above, it requires about 100 pounds of muriatic acid of 22° B. for leaching 100 pounds of bones. This makes the process rather expensive, and the attempt has been made to replace muriatic acid by sulphuric acid, and it proved successful, when proper care was taken. Sulphuric acid is largely used in the muriatic acid process, as well as in the phosphoric acid process, and the cost is thereby greatly reduced. It requires about 1,300 pounds of sulphuric acid of 60° B. to leach 2,000 pounds of bones. The manner in which this is accomplished is as follows: The bones are covered, to begin with, with a weak solution of muriatic or phosphoric acid. The saturated acid is drawn off, and the monophosphate of calcium in this solution converted into phosphoric acid by adding a certain amount of sulphuric acid.

The sulphate of lime formed is allowed to settle, and the clear solution to run back again onto the bones. This is repeated as often as required to finish the process, i. e., to render the bones soft and transparent. The time required for this process is increased from the time required for the muriatic process to the length of time required for the phosphoric acid process, as the entire amount of muriatic acid used in the start forms but a small percentage of the total active acid. In this manner of working the phosphoric acid solution gets stronger and stronger, as the entire phosphoric acid of the bones is dissolved and helps to dissolve new quantities of the bone. It might seem that a very small quantity of acid would be sufficient, as this acid get stronger, and could be used over and over again. But this is not the case; the strong acid does not dissolve the bones as rapidly and completely as weak acid, and it is, therefore, necessary to dilute the strong acid solution; this is done with the weak waters obtained when the soft bones have been covered with clean water to recover the greatest part of the acid in the bones, before the bones go into the actual washing process. Bones receive usually three or four clear waters, and these weak solutions run in the leaching acid before same is mixed with the sulphuric acid. After the acid has been used for some length of time its dissolving power is constantly decreasing, and finally disappears almost entirely. This is due to the great amount of alkali salts, especially sulphate of magnesia and sulphate of sodium, which accumulate in the acid. Generally such acid is of a dark brown color, and possesses a mouldy odor. It must be allowed to run away from time to time, as it is of no more use, and a new start must be made with freshly prepared acid.

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Utilization of By-Products From the Manufacture of Gelatine.

A good deal of fine bone dust is produced in crushing the bones and horn piths. This dust would be a complete loss if it were put into the acid to be leached, because it would be washed away and inevitably escape into the sewers. It is, therefore, better to screen the crushed material, thereby separating the fine dust, which is to be boiled with limed glue stock, giving in this manner a good quality of glue, besides giving a full yield and helping to clarify the hide glue. The tank refuse of this glue stock will be a very good fertilizer, showing 7 per cent. ammonia and 25 per cent. phosphate.

The utilization of the phosphoric acid is another item which, if properly taken care of, helps to reduce the cost of making gelatine. Immense quantities of phosphoric acid are rendered solid by the leaching process. As long as the acid is dissolving bones (active acid) it is used over and over again, but if the acid loses its dissolving power for bones, which occurs only when large quantities of soluble sulphates are present, such as sulphate of magnesia, sulphate of sodium and of ammonia, this acid must be taken out of the process. There are different ways of utilizing this acid.

First—The entire phosphoric acid in form of monocalcium phosphate is evaporated to syrup consistency and used in the manufacture of phosphorus. The evaporation is a difficult process on account of the large quantities of sulphate of calcium present, which forms a hard crust on heating pipes and walls of the kettle, and may thereby stop the concentration entirely.

Second—The entire phosphoric acid is precipitated with lime as bicalcium phosphate. This separates and settles easily, and the clear supernatant liquor which contains all soluble salts, as chloride of calcium and sodium, is allowed to run into the sewer. The bicalcium phosphate (in German called kalk precipitat, or futter kalk), is of a very nice, white color, and can be readily ground into fine powder containing from $\frac{1}{4}$ to $\frac{1}{2}$ per cent. ammonia and 35 to 45 per cent. phosphoric acid, according to the care given to its production. It is a high grade fertilizer, as the entire phosphoric acid is available and soluble in organic acids. If mixed with potash and ammoniates it makes a complete fertilizer of general utility. Bi-calcium phosphate in its purest form can be used in the manufacture of baking powder on account of its richness in phosphoric acid. It can also be used in the manufacture of phosphorus, and for this purpose is far better than burned bones, being free of fluoride of calcium and requiring less sulphuric acid to convert into monocalcium phosphate, giving thus only one-half the quantity of sulphate of lime. Very little attention is given to the manufacture of phosphorus in this country, England still supplying almost exclusively all the phosphorus used in the manufacture of matches.

Third—The acid liquor is moderately concentrated with the acid of waste heat, and the concentrated liquor is mixed into bone meal and tankage before being run through a dryer. This process improves the quality of the fertilizer to a great extent.

A good deal of fat can be recovered in the leaching vats in the manufacture of bones by having the vats skimmed frequently; $\frac{1}{4}$ to $\frac{1}{2}$ per cent. of grease may thus be recovered from bones containing 3 per cent. of grease. Of course, this fat has a very bad odor and contains large quantities of free fatty acid, but compares favorably with No. 2 tallow or with poor bone grease.

By running the waste water obtained in washing the raw gelatine through catch basins a great deal of phosphoric acid, waste lime and ammoniates can be recovered by having the catch basins cleaned frequently.

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About Dissolving of Glue and Preparing Same For Use.

The ordinary and usually practiced method of dissolving glue, consisting in soaking the glue for some time in cold water and then heating it on a water-bath, has one great drawback: It requires considerable time. Even when ground glue is used, the preparation of the glue for cabinetmaker's and other uses takes from one to three hours and more, depending on the size of the glue particles. Glue in shreds requires soaking for several hours, usually overnight, to get the glue into condition where it will readily dissolve on the water-bath.

A U. S. patent lately granted to Mr. Friman Kahrs, of New York, throws some very interesting light on the possibility of dissolving glue rapidly . His invention relates to improvements in processes for dissolving glue and for the making of clay size, and its object is to expedite the dissolving process and to insure the production of a glue solution and of clay size of improved quality, to do this more rapidly, with less power, and at a lower cost than heretofore.

The nature of the process referred to is best understood by a careful study of his patent specification, of which we print here some interesting portions:

A. The Dissolving of Glue.—In dissolving glue it is usual first to soak the glue in cold water, the glue taking up a certain amount of it and swelling to a jelly, which is then melted in a glue-pot. When melted it is boiled in order to make it "fit for use," as the popular notion is that the glue will not yield full strength without boiling. The soaking is deemed necessary, because experience shows that hard glue dissolves very slowly in hot or boiling water, as it forms tough, sticky lumps that resist reduction; but, on the other hand, it was found that if the glue had been steeped in cold water and had absorbed some of it, the melting of the jelly was always comparatively easy; therefore the soaking. This experience in regard to soaking and the popular belief as to the boiling are both so strongly imbued by all glue consumers that it was only after repeated demonstrations of the waste of time by soaking and the evident damage done by boiling that I found it necessary to inquire into the real facts by suitable experiments in order to discover the truth, and this is what I found:

1. Thirty gallons of water heated in a water-bath could be brought up to 210° F. in twenty-five minutes, but the same quantity of a thirty-five per cent. glue solution in the shape of a stiff jelly required from ninety to one hundred and twenty minutes for the same result.

2. One pound of steam would heat one thousand five hundred and forty pounds of water 1° Fahrenheit, but the same amount of steam would only heat four hundred and seventy-five pounds of a mixture of water and glue (and some clay). It was clear then that glue and glue solutions were poor transmitters of heat, and that this caused the delay in heating.

3. Experiments with glue jellies had shown that the stiffness of the jelly decreased the nearer the temperature rose to the congealing-point; also that if the temperature exceeded this point by only a few degrees the jelly became liquid; also that nearly all glue solutions had a congealing-point below 95° Fahrenheit.

4. While using very warm glue solutions, say above 160° Fahrenheit, it was found that hard glue put in such solutions became soft and very sticky and hard to dissolve.

5. Examination of glue pieces that by soaking in cold water had become jellified showed the water to have been absorbed gradually toward the center, indicating that the hygroscopic qualities of the glue had been assisted in

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the water-absorbing act by a certain natural porosity of the glue while cold.

6. This porosity of the hard cold glue changed into stickiness and did not disappear before the heat began to soften the glue itself, and this softening changes gradually into stickiness as the temperature of the glue solution increases.

7. The softness of the very warm glue had evidently changed the porous condition of the cold glue, and by closing the pores and increasing the natural adhesiveness by increase of temperature induced a stronger cohesion and caused the delay in dissolving the hard glue in the hot glue solution or in hot water.

8. If a temperature slightly above the congealing-point of the liquid was used for melting the glue, there was no jelly formation and no stickiness or clogging of the glue particles and the dissolving process went on rapidly and evenly, especially if the denser parts of the solution and the still unmelted glue were by stirring prevented from sinking or settling at the bottom.

9. Practical trials proved that thirty gallons of a thirty per cent. glue solution could be prepared in twenty-five minutes if kept at a heat not over 120° Fahrenheit and if stirred while dissolving.

10. As this was an unboiled solution and as it might not be considered as strong as a boiled solution, a test was made with some of it boiled and some unboiled, both worked into test-pieces alongside of each other. The unboiled glue was stronger by twenty per cent., proving this to be the amount of damage done to the glue by boiling.

11. The practical strength trial had here confirmed what the soaking of glue in water had indicated—namely, that glue immersed in cold water absorbs same perfectly and forms a jelly, indicating that glue and water will mix

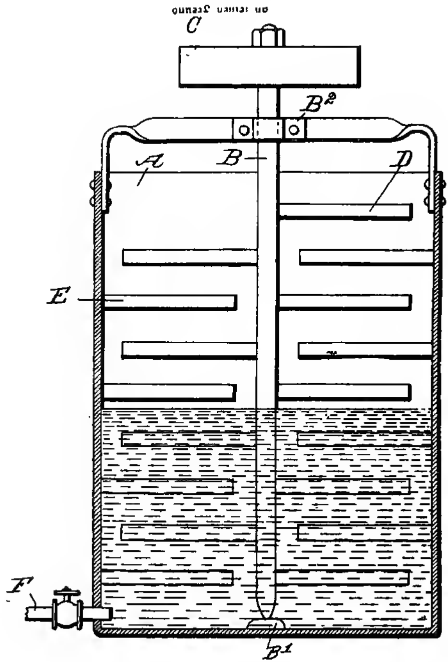
or unite mechanically very well without the use of heat and that a perfect union of glue and water might be possible without any heat at all without forming a solution.

12. All this had been repeatedly indicated by my experiments, but had never been acted on, as it was absolutely against popular belief and as it lacked the confirmation of practical trials.

I was thus convinced that it was not alone desirable, but even necessary, to abandon the fallacious notions of "soaking" and boiling glue and reshape the dissolving process on the basis of indications given by the above-noted experiments. In order to prevent any possible damage done to glue by heat or heating, I have devised the following process, where I have used to advantage the better understanding of the physical phenomena relating to the dissolving of glue in water, as acquired through the knowledge gained from the experiments described. Glue itself is, as before stated, a very poor conductor of heat, and so are glue solutions in jelly form, as they prevent the convecting currents that always promote the heating of liquids. The best way is, therefore, to take advantage of the superior heat-absorbing qualities of water by heating it to the proper temperature before the glue is added, then to add the glue, taking care not to apply any heat to the mixture after the glue is added, and these are the substantial features of the new process. This process was tried and worked very well indeed, because when glue is put into luke-warm water the heat is applied to all parts of the glue at once, jellification is prevented, the formation of sticky lumps is impossible, and the dissolving action is comparatively rapid. I find, however, that to give uniform and good results and to increase the rapidity of solution it is better to stir or agitate the mixture after the glue is added to the warm water, first, because this removes the viscous glue solu-

MEMORANDA

tion from the surface of the glue particles as fast as it is formed, thereby exposing continuously new portions of the hard glue to action of the surrounding water liquid, and, secondly, because otherwise the heavier glue particles and glue solution would sink to the bottom and



remain there. For reasons formerly stated the temperature of the water at the start must be high enough to raise the final mixture of glue and water above its congealing-point when dissolved; but this temperature must not be high enough to materially soften the hard glue. From 90° to 120° Fahrenheit I have found most suitable for low-grade glues.

Over the old process of melting glue the new one has the following advantages: First, the preparation is done more rapidly. Thirty gallons of a thirty to a forty per cent. solution can be dissolved in one-third or one-fourth the time formerly required. Second, the spoiling of the glue by overheating or boiling is done away with entirely. The damage now done by using steam or hot water to heat glue is often very large, especially if it is attempted to hasten the action, and sometimes the value of glue solutions have been reduced by fifty per cent. or more.

Mr. Kahrs says, in the patent referred to, the following in regard to the dissolving of glue, with special reference to ground glue. It is one of the weightiest arguments we have ever read for the use of ground glue, and both manufacturers and consumers will find it of special interest to study this part carefully.

For a better understanding of the process I refer to the accompany drawing, which represents a vertical section of a mixing or stirring apparatus adapted to the carrying out of the dissolving of glue.

A is a vessel or tank in which is mounted a mixing or stirring device, consisting of a shaft B, driven by any suitable means, as by a driving wheel C, and having projecting arms or blades D, which co-operate with fixed blades E, supported from the sides of the tank. Said shaft is provided with a bearing B^1 at the bottom of the tank and journaled in a suitable bearing B^2 at the top.

F is a nozzle or pipe connecting with a source of live steam.

In making a glue solution the amount of water necessary to form a batch of liquid glue is put into the tank A, and the steam is then admitted through the pipe F until the water is warmed to the proper degree, or until it is lukewarm, but not so hot that the hand cannot bear it.

The temperature to which the water is heated depends to some extent on the amount of glue to be added, but it must be sufficiently high to give to the final mixture a temperature somewhat above the congealing-point of the glue solution itself, while not high enough to cause any lumpiness or sticking together of the dry glue particles, due to excessive softening of the latter. I have found that temperatures not above 120° Fahrenheit and not below 90° Fahrenheit are the limits for ordinary conditions of practice for low-grade glues, and it is within these limits of temperature that I prefer to work. At temperatures higher than 120° Fahrenheit the glue itself is as stated, liable to soften independently of the action of water and the glue particles resist and retard solution by sticking together and forming lumps, while temperatures below 90° Fahrenheit may bring the final temperature below the congealing-point of the glue solution and then prevent a perfect mixture to be formed and prevent adhesion of the glue. The water having thus been brought to the desired temperature the steam supply is cut off and the necessary amount of glue, preferably in a finely divided condition, is introduced into the tank. The mixer is then set in motion and the particles of glue are quickly dissolved, since the agitation brings each glue particle into continuous contact with a larger quantity of water than would otherwise be possible, this because the rubbing of the particles against each other and against the liquid detaches the viscous melting surface therefrom as fast as formed and hastens the melting and the dissolving by continuous exposure of more surface on the particles to the dissolving action. By taking advantage of the superior heat-absorbing qualities of water and by imparting all the necessary heat to the water beforehand I obtain a rapid and uniform heating of the resulting mixture of glue and water, while there is absolutely no possibility of damage

MEMORANDA

done to the glue by overheating, since no heat is supplied to the mixture after the glue is added. A lumpy coagulation of the glue particles is at the same time completely prevented, for while the temperature is above the setting-point of the glue solution it is too low to cause softening and clogging up of the glue itself. The result is a smooth and uniform and perfectly liquid glue solution obtained with a minimum of heat and at the expense of a short time and a little power.

[We have tried Mr. Kahrs' process and found it to be just what he says it is, and his process is now, by special arrangement, used in our laboratory whenever glue is dissolved. We think those interested ought to write to Mr. Kahrs and make arrangements for the use of his patent. For paper makers and manufacturers of kalsomine and the like, the patent will prove specially interesting, as it refers to these arts as well.—The National Provisioner.]

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MANUFACTURERS AND DEALERS IN GLUE AND GELATINE IN THE UNITED STATES AND CANADA.

NOTE. Names preceded with asterisk (*) are those of dealers; with a dagger (†) those of gelatine manufacturers. A number of the glue manufacturers listed below are also manufacturers of gelatine.

CALIFORNIA.

Corder, F. W. . . . . Golden Gate
Holje, Martin . . . . 106 Pine St., San Francisco
Kunitz, E. . . . . Santa Cruz
Russia Cement Co. . . . . 23 Davis St., San Francisco

CONNECTICUT.

Parks, Chas. D. . . . . Danbury

DELAWARE.

Delaware Glue Works. . . . . Wilmington

DISTRICT OF COLUMBIA.

*O'Meara & Co., John D., 1301 9th St., N.W., Washington

GEORGIA.

*Chapman Glue Co. . . . . 13 N. Forsyth St., Atlanta

ILLINOIS.

American Glue Co. . . . . 27 Market St., Chicago
Armour Glue Works, Benson, bet. 31st and 32d Sts., Chicago
Baeder, Adamson & Co. . . . . 182 Lake St., "
Chicago Ink Co. . . . . 59 S. Canal St., "
Diamond Glue Co. . . . . 31st and Robey Sts., "
Illinois Glue Co. . . . . Cass Ave. and 45th St., "
*Kirk, Henry D. . . . . 26 W. Randolph St., "
Lister, Joseph. . . . . 1156 Elston Ave., "
Russia Cement Co. . . . . 25 Lake St., "
Swift and Company. . . . . "

*Wisdom & Co.................206 Lake St., Chicago

INDIANA.

Conrad & Kammerer...................New Albany
Hammond Glue Co......................Hammond
Kingan & Company, McIntyre and West Sts.,
Indianapolis
Madison Fertilizer and Glue Works...........Madison
*Vonnegut, Clemens..184 E. Washington St.,
Indianapolis

KENTUCKY.

Tanners' Offal Co., Story Ave. and Pocahontas St.,
Louisville

MAINE.

Seavey, G. H..............................Hallowell

MARYLAND.

Baker Bros. & Co............36 Charles St., Baltimore
Baugh & Sons Co.......412 Exchange Place, "
Bullock, John & Son.....205 Smith's Wharf, "
Coulson, E., & Co......................... "
Henry, Noah O............35 Gutman Ave., "
Steir, Henry W. D..............Mt. Winans, "

MASSACHUSETTS.

American Glue Co............415 Atlantic St., Boston
American Glue Co..........Washington St., Peabody
Anderson, John M..........................Salem
Atlantic Glue Co................36 Broadway, "
Baeder, Adamson & Co (factory).............Woburn
Beach Soap Co...........................Lawrence
Boston Glue Works.......................Boston
Cape Ann Isinglass Co....................Rockport
Cilley, Brad. J.......................New St., Boston
Davis, Wm. A., & Co. (Jas. Atherton, mucilage manufacturer).......................7 Northfield, Boston

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Dodd, A. W., & Co................5 Wharf, Gloucester
Deike, D. F., & Son..........191 High St., "
Ellwell, Benj. F.............................Rockport
Ferdinand, L. W., & Co......267 Federal St., "
Flint, P. P.................................Lowell
Fuller & Steinhauser (sizing)................. "
Gloucester Glue Case Co...................Gloucester
Gloucester Isinglass & Glue Co., 109 Prospect St., Fall River
Holt, Jonathan & Co...........270 Tanner St., Lowell
Hub Fish Glue Co ....223 Commercial St., "
Haskins, L. M., & Co. (isinglass)..............Boston
Improved Process Glue Co......Fort Point, Gloucester
International Glue Co..........8 Oliver St., "
Jeffords, J. G...........Off Greenwood St., Worcester
Mills, F.... ....Needham
Norwood, C. J. (isinglass)...................Ipswich
Robinson Bros............Ft. Whittemore, Gloucester
Russia Cement Co. (gelatine), off Essex Ave., "
Sawyer, F. M...........8 Cambridge Terrace, Allston
Searles, M. L.................687 Summer Ave., Lynn
*Shattuck & Son, Horace B....50 Central Ave., Lowell
Shea, Daniel, & Bro..............Newton, Upper Falls
Standard Liquid Glue Co....53 Central Wharf, Boston
Sullivan, James.......55 Lincoln, Newton, Upper Falls
Sullivan, James.........................Marblehead
Tarr's Islinglass Co............45 Fort Sq., Gloucester
Taylor, Addison.........................Taunton
Union Glue Co..................102 High St., Boston
Whiten, J. O., Co............68 Western Ave., "
Wiggin & Stevens.........................Malden
Winward, James............Winward Ave., Fall River
Worson, H. A...........Rocky Neck Ave., Gloucester

MICHIGAN.

Barry Bros., Ltd..........Wight and Lieb Sts., Detroit
Boland, James..............................Jackson
Fischer Bros................................Delray
Fitch Fertilizer Works (poultry food)..........Bay City
Grand Rapids Glue Co.................Grand Rapids
*Heal, George......... ..... .1120 River St., Detroit
Jackson Rendering Works...................Jackson
Michigan Carbon Works...........5 Front St., Detroit
Schreidt, August ....Muskegon

MINNESOTA.

Adams Mfg. Co...........409 Sixth Ave., Minneapolis
Fuller, H. B..................173 W. 3rd St., St. Paul
Kaiser, E., & Co...........................Winona
Minnesota Transfer Packing Co...........Minneapolis

MISSOURI.

Chittenden, C. L...............15 S. 4th St., "
Dold, Jacob Packing Co........... .....Kansas City
Heller, Michael.... ....1709 N. 8th St., St. Louis
Kansas City Glue & Fert. Works. (Peet Bros. Mfg. Co.) ....Kansas City
Mathiason, P. B., & Co.......5310 N. 2d St., St. Louis
Neuer, Ernest. ....5746 Manchester Rd., "
Peet Bros. Mfg. Co......................Kansas City
Reardon Glue Co..........1015 Lucas Ave., St. Louis
Schwarzschild & Sulzberger Co...Osage Ave., Kansas City
*Stuyvesant Glue Co., Burd.....321 N. 2d St. St. Louis
Tamm Bros. Glue Co.... ......16 S. 2d St., "
Tamm, John J.... ....3864 Shaw Ave., "

NEBRASKA.

Cudahy Packing Co....................South Omaha

NEW HAMPSHIRE.

Keene Glue Co........... ....Keene
Wiggin & Stevens..............89 Cocheco St., Dover

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Sworn to before me 2 day of April 1898

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De Clyne, Chas., Est. of..................New Durham
Lane, F. T. L........Ferry and Blanchard Sts., Newark
Lister's Agricultural Chem. W'ks..Lister Ave., "
New Jersey Glue Works............Ferry St., "
Pashley, F ....Trenton
Ward, M. L...............................Paterson
Weiss, Constantine.......322 Preakness Ave., "

NEW YORK.

American Glue Co...........197 Water St., New York
*Arabol Mfg. Co..............13 Gold St., "
Armour Glue Works.........182 Duane St., "
Baeder, Adamson & Co....67 Beekman St., "
*Behr, Herman, & Co......75 Beekman St., "
*Blehden, V. R. (curled hair),...255 Bryant St., Buffalo
Brower, & Son, A......321 W. Fulton St., Gloversville
Buffalo Glue Works (B. J. Cilley)..............Buffalo
Chalmers, James ....Williamsville
Cooper's Glue Factory, Peter, Maspeth Ave. and Gardner ....Brooklyn
Couch, B. T., & Co..........166 S. Park Ave., Buffalo
Couch, A. S..................215 Tuttle Ave., Elmira
Deike, D. F., & Son........602 W. 52d St., New York
Delany & Co..................306 Pearl St., "
*Dolan, J. B. Glue Co........245 Pearl St., "
*Duche, T. M., & Sons (importers), 101 Water St., New York
*Dunn, T. W. (gelatine also) 47 Beekman St., "
Evans, Richard................355 Abbott Rd., Buffalo
Fulton County Glue Co........Maple Ave., Johnstown
Gaensslen, Fisher & Co.....................Gowanda
*Gardiner, A. K., & Bro......284 Pearl St., New York
Gardner Pulp Co. (sizing)................Gouverneur
Herzfelder, Bernhard.........15 Crosby St., New York
*Hewitt, C. B., & Bros.....48 Beekman St., "

*Hodge, A., & Co. (also importers), 108 Broad St., New York
Holthusen, Alex. (broker)......284 Pearl St., "
Hoyt, A. S...............126 Chambers St., "
Improved Process Glue Co....94 Reade St., "
*Isaacs, S., & Co.............299 Pearl St., "
*Jones, B. W................38 Spruce St., "
Kergott, Chas., & Co......................Gowanda
Knox, C. B. (gelatine also)..17 Chestnut St., Johnstown
*Leggett & Bro...............301 Pearl St., "
*Leibundgut, E. A. (importer)..23 S. William St. New York
Lister's Agri. Chemical Wks..159 Front St., "
Long Island Agri. Chem. Co.Long Isl. City, "
*Magnus, S., & Co. (importers) 275 Pearl St., "
*Marks & Meyer..........40 W. Broadway "
McLeish, E. E., & Co. (gelatine).............Buffalo
Milligan & Higgins Glue Co..222 Front St., New York
Olean Glue Co...............................Olean
Parsons, W. N., & Co...................Binghamton
Pennsylvania Glue Co......................Buffalo
Pfeffer, L., & Sons (gelatine).................. "
Preston Fertilizer Co.......Box 1, Station G, Brooklyn
*Putnam, T. L., & Son (gelatine also)..186 Front St., New York
*Salomon & Schwartz......112 William St., New York
Somerset Chemical Co. (gelatine) 52 Wall St., "
Stappenbreck, H. (boneyard).........Grand St., Utica
*Taylor's Sons, Geo. F..........80 Pine St., New York
*Toch, J. L. & J................85 Pearl St., "
*Townsend, Chas............276 Pearl St., "
*Waddell, R. J., & Co. (importers), 52 Beekman St., New York
Zuker & Levatt Chem. Co.......Maple Ave., Flushing

OHIO.

Ahrendt, Herman . . . . Columbus
Berk, Kingery & Co. (gelatine). . . . . Hamilton
*Bird Glue Co. . . . . Third and Main Sts., Cincinnati
Cincinnati Glue & Paste Co., Plum and Mohawk Bridge . . . . "
Kingery, S. S. (gelatine). . . . 131 E. Pearl St., "
Ohio Glue Co. . . . . 127 E. Pearl St., "
Rickerstaff, Jas. L. . . . . 2800 Broad St., Richmond
Sanders, Robert . . . . Urbana
Stephens & Bro., Miami, Canal and Marshall Sts., Cincinnati
Stockerberger, J. C. . . . . Canton
Strecker, John . . . . Marietta

PENNSYLVANIA.

American Glue Co. . . . . 219 S. Canal St., Alleghany
Baeder, Adamson & Co., 730 Market St. (headquarters) . . . . Philadelphia
Baugh, B., Son & Co. . 20 S. Delaware Ave., "
Delany & Co. . . . . 155 Jefferson St., "
*Erterline & Steidle. . . . . . 252 S. Main St., Williamsport
Keystone Glue Mfg. Co. . . . . Warren
Levan, Joseph . . . . Reading
Levi & Simonia. . . . . Philadelphia
Lamparter, Elizabeth. . . . . Rockland St., Lancaster
Morrow, J. . . . . Newport
Pennsylvania Glue Co. . . . . Springdale
Rohill & Morrow. . . . . Harrisburg
Sickler Bros. . . . . Butzbach Station, Williamsport
Talbot, S. S. . . Bermuda and Tucker, Fkd., Philadelphia
*Taylor, R. T. . . . . 706 Market St., "
Troutman, Joseph . . . . Clearfield
Tunnell, F. W., & Co. . . . . . . 15 N. 5th St., Philadelphia
*Wilhelm, Henry. . . . . 4 Fountain, Pittsburg

RHODE ISLAND.

*Chambers, Calder & Co..21 Exchange Pl., Providence
Darling, L. B., Fertilizing Co................Pawtucket

VIRGINIA.

Christian, Thomas.......1418 E. Main St., Richmond

WASHINGTON.

Baker & Rickards................107 S. 2d St., Seattle

WEST VIRGINIA.

Gilliland, R. M.............................Wheeling

WISCONSIN

Brumer, Franz ....Tess Corners
Manitowoc Glue Co............... .....Manitowoc
Russe, F ....Berthelet
Schneidt, A. L........... ... .Milwaukee
Wahl, Frederick...........292 S. Water St., "

CANADA.

Ontario.

Harris, W., & Co.. ....420 Pape Ave., Toronto
Hawkins, Geo...................... ......Pt. Hope
Huber, J. T., & Co....... ....Doon
Leheup, Henry ....Barrifield
Reid Bros ....Birchton
Wintermeyer, John H............. ....Berlin

Quebec.

Auld Mucilage Co.............759 Craig St., Montreal
Fox, Thomas M............60 N. Bank St., "
Jamieson, R. C., & Co.........13 St. John S., "
Jonas, H., & Co................389 St. Paul, "
Lefsieffer, Ed...............30 Hospital St., "
Montreal Size Co...............Cote St. Paul "
Tellier, Rothwell & Co......8 De Bresoles St., "