

(10 43 in.) diameter, and 630 millimetres (24·8 in.) The ordinary cut-off is  $\frac{1}{33}$  of the stroke, variable from 1 to 6 by the governor. The working steam pressure is intended to be 60 lb. per square inch, and the revolutions 65 per minute.—*Engineering.*

### GLUE.

Glue is a highly useful and important substance, and its manufacture is carried on upon a large scale, as follows:—The parings of hides, and pelts from the tanners and furriers, and the clippings of hides, hoof, horns, feet or calves, cows, sheep, pigs, and various membranes, are the substances from which it is extracted in Britain. These are first placed in a lime-pit, and when sufficiently steeped, they are carried in baskets to a stream of water and washed, after which they are placed on hurdles to dry. Whatever lime remains adhering to them is converted into chalk by the action of the air; and though lime would be injurious to the after processes, yet the presence of a small portion of chalk is immaterial.

The pieces having been thus cleaned, the next process is the extraction of the gelatine from them by boiling. For this purpose, they are placed in a wide-mouthed bag or net, made of rope, and spread open within a large iron cauldron. A light framing of iron within the cauldron prevents the bag from sticking to its sides. Water is then added, and gradually brought to the boiling point; as the animal substances sink, fresh quantities are added, the whole being occasionally stirred up and pressed down with poles. The state of the substances is tested by occasionally taking out a portion, and setting it aside to cool; if a clear mass or jelly be produced, the boiling has been sufficient. The mouth of the bag is then closed by means of cords, and the bag is slowly hoisted by machinery until it rests against, or partly coils around, a beam immediately over the cauldron, which helps to press out the liquid. In this state, it is left to drain. Meanwhile the contents of the cauldron, if not strong enough for glue, can be further evaporated by continuing to apply heat. The contents of the bag are boiled a second and a third time for making size, and when the solutions are too weak for either glue or size, they are economically used instead of water. The last remaining refuse is sold for manure. Thus, every portion of animal substance is turned to profitable use.

The glue in the cauldron, when thick enough, is drawn off into a vessel called a settling-back, and maintained at a temperature which will keep it liquid. This gives time for the deposition of solid impurities, and for further clarification by the addition of such fining substances as the manufacturer may prefer. The glue is then run off into wooden coolers about six feet long, one foot broad, and two feet deep. Here it becomes a firm jelly, which is cut out by a spade into square cakes, each cake being deposited in a sort of wooden box, open in several slits or divisions to the back. The glue is cut into slides by passing a brass wire, attached to a kind of bow, along the slits. These slides are placed upon nets (the marks of which are seen on the dry glue), and stretched on wooden frames, and are thus removed to the glue-maker's field, where they are placed in piles, with proper intervals for the admission of air, each pile being roofed in as a protect on from the weather. The glue is turned two or three times a day, and for this purpose the roof is lifted off the pile, and the uppermost frame placed on the ground. The cakes are turned one by one, and then the second frame is lifted off and placed on the first. The operation is thus repeated until a new pile is formed near the spot where the old one stood, when the roof is replaced.

During the drying, the glue is more likely to receive injury than at any other period. In very warm weather, the cakes are liable to become so soft as to lose all shape and unite with the frames or they may even melt entirely, and flow away. A thunderstorm sometimes prevents a whole field of glue from hardening, while a thick fog may make it all mouldy. A brisk drying wind may harden it so suddenly as to render it unsightly and unfit for the market. A hard frost, by freezing the water in the glue, may cause it to crack in all directions, rendering remelting necessary. Thus the manufacture has many vicissitudes to suffer, and can only be profitably and conveniently carried on in temperate and equable weather. The drying, however, is not entirely finished in the

open air. When the glue is about three parts dry, it is removed to lofts, where, in the course of some weeks or months, the hardening is completed. But as the surfaces of the cakes become mouldy and soiled, it is at length necessary to scour them with a scrubbing-brush and hot water, and set them up to drain. They are then finally dried off in a stove-room at an elevated temperature, which, when they are once solid, only serves to harden and improve them.

After stove-drying, the glue is fit for the market, where it is judged of by its strong dark colour, and freedom from cloudy or black spots when held to the light. The better sorts of glue are transparent, especially the thin cakes of the Salisbury glue, which are of a clear amber colour. The best glue swells without melting when immersed in cold water, and renews its former size on drying. The method of softening it for use is to break it into small pieces, soak twenty-four hours in cold water, and then melt slowly over a fire with frequent stirring. When prepared in this way it cools down into a stiff jelly, which requires only a little warming to fit it for use. Glue must not be used in a freezing temperature.

A strong compound of glue is made by infusing common glue in small pieces with isinglass in spirits of wine, just sufficient to cover the mixture. Heat is then cautiously applied, and when melted, powdered chalk is added, making the whole of an opaque white. A strong glue, which will resist water, is also obtained by adding half a pound of common isinglass to two quarts of skimmed milk, and evaporating the mixture to a proper consistency. If gelatine, which has been swelled in cold water, be immersed in linseed-oil and heated, it dissolves and forms a glue of remarkable tenacity, which when once dry, perfectly resists damp. Ordinary glue may thus be dissolved, and a small quantity of red lead, in powder, added.

It appears from the observations of Mr. Schattenmann, a glue-maker, that fresh glue dries much more readily than glue that has been once or twice melted; and that dry glue steeped in cold water absorbs different quantities of water according to the quality of the glue; and the proportion of water so absorbed may be used as test of the quality of the glue.

It appears that fresh glue contains water of composition, or water more intimately united with the glue than water mixed with it in the process of melting, which admits of being readily disengaged by evaporation. The combined water of dry glue disappears in the course of successive meltings and solidifications to which glue is subjected. Glue in thin plates is usually of better quality than thick ones, even when made with the same kind of gelatine, because the thin plates admit of a more complete drying than the thick. In applying M. Schattenmann's test, dry glue is immersed for twenty-four hours in water at the temperature of about 60° Fahr. A jelly will thus be formed, the qualities of which will fairly represent those of the glue. For example, the finest ordinary glue, or that made from white bones, absorbs twelve times its weight of water in twenty-four hours, so that a plate weighing three grammes produces thirty-nine of fine elastic jelly. Glue from dark bones absorbs nine times its weight of water, and produces not quite so fine a jelly. The ordinary glue of Alsace or of Germany, made from animal refuse, absorbs five times its weight of water, producing a soft brown jelly, without elasticity and consistence, and falling to pieces when handled. The common glue of Boulogne absorbs three and a half times its weight of water.

Well-dried glue is much less hygrometric than badly made glues, or those made of inferior materials. The latter are liable to putrefaction. The water of composition seems to be injurious to the strength of glue, which increases in proportion to its dryness.

Glue or gelatine has lately been applied, with great success, to the formation of moulds for castings. The difficulties attending the use of sand, clay, plaster of Paris, wax, &c. in forming moulds for casting, are very great where the objects to be repeated are complicated in form. About the beginning of the present century the Germans introduced the use of glue for making moulds, which was not employed in this country until about the year 1826, when Mr. Douglas Fox used it to take casts from his anatomical preparations, calcareous concretions, vegetable preparations, &c., and in order to give greater elasticity to the moulds so obtained, and to keep them in a fit state for use during a long period, he mixed treacle with the glue; this, however, was found to discolour