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AMERICAN INDUSTRIES.—No. 8.

ALE BREWING,

As conducted at P. Ballantine & Sons' Brewery.

Beer was known to the Egyptians, and it is probable that the Greeks learnt from them the art of brewing. The Romans obtained their knowledge of beer from the Gauls, and like them, called it *cerevisia*. In Germany the brewing of beer has been carried on for many centuries, the fact being mentioned by Tacitus. As long as the malt required was prepared in each house the beer industry remained comparatively undeveloped; but when the monasteries began to brew on a larger scale it attained considerable perfection. The monks were the first to make a distinction between "double beer" and "single beer." The use of hops in brewing dates from the ninth century. White beer was first brewed in Nüremberg, in 1541. The brewing of ale and porter—which are species of beer—dates only from the eighteenth century. Until within the present century brewing was empirical, but modern research has placed it on a truly scientific basis.

To bring before our readers some facts relative to the brewing of ale, we give engravings illustrative of the industry as at present carried on by Messrs. P. Ballantine & Sons, of Newark, N. J.—this establishment being the largest and one of the oldest of its kind in the United States. It has been in existence for more than forty years, and has been located in Newark since 1840.

Since the organization of this business by the elder Mr. Ballantine, in 1835, in Albany—then the headquarters of the brewing business—this industry has slowly but steadily developed until it has reached gigantic proportions. The establishment of Messrs. P. Ballantine & Sons, covering about

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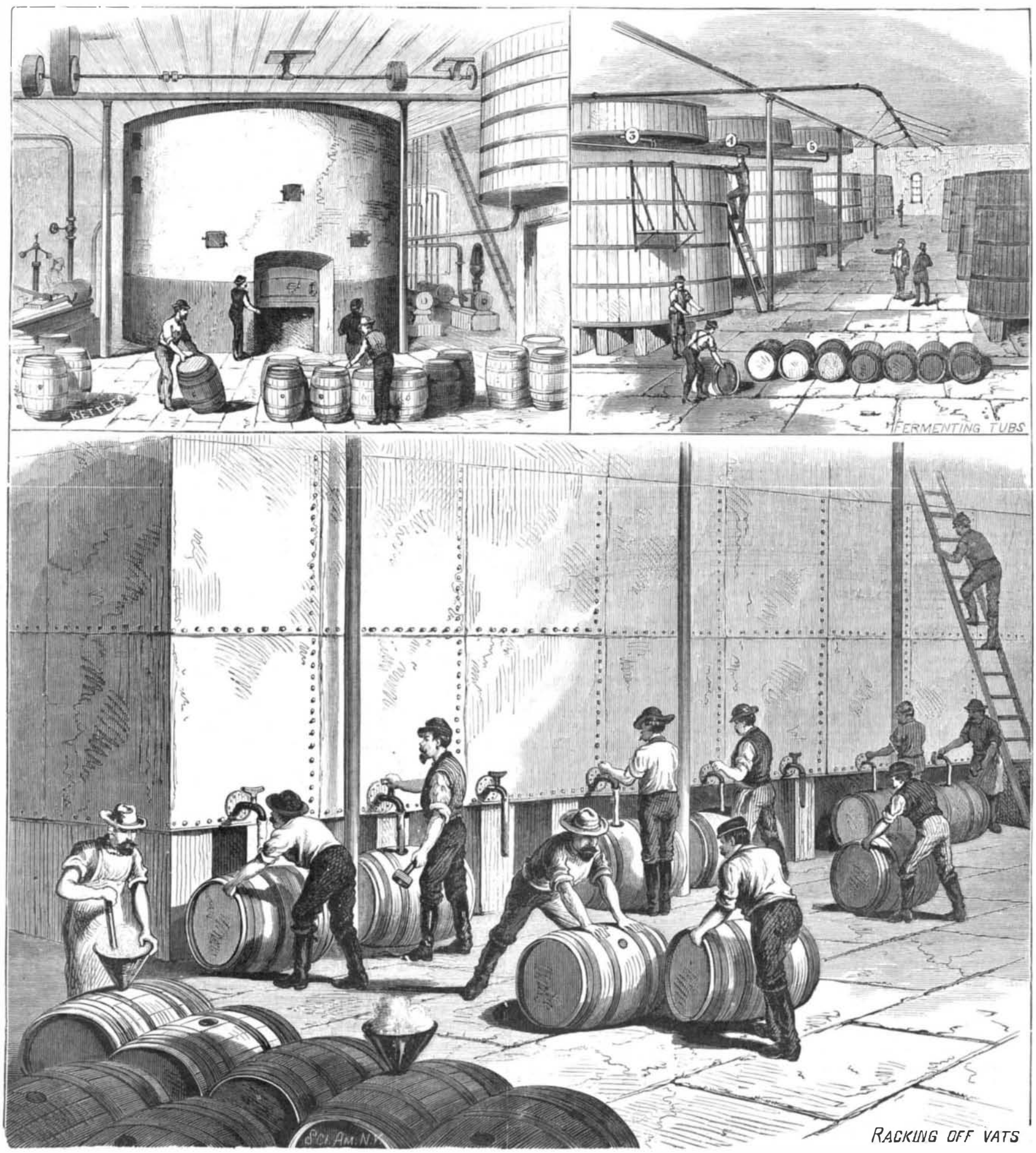


THE BREWING OF ALE.

ALE BREWING.

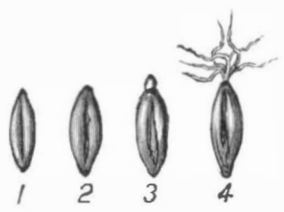
[*Continued from first page.*]

seven acres of ground, has a frontage on the Passaic river of 600 feet; this, in conjunction with the railway lines on the opposite side of the premises, afford the most extensive facilities for receiving and shipping materials and products.

The raw materials used in brewing are barley, hops, yeast, and water.

By letting the barley pass through the process of an interrupted germination an unorganized ferment, diastase, of the nature of the ptyalin of the saliva, is formed, which has the property of changing the starch of the kernel into grape sugar (glucose) and dextrine. To induce germination the grain has to be supplied with moisture, heat, and oxygen, and upon the proper regulation of the three depends the success of malting. The barley is steeped in water until it has absorbed about 50 per cent of the liquid, and then spread on cemented floors. The kernels soon commence to grow and to absorb oxygen, which causes a slow combustion and the generation of carbonic acid gas and heat. By turning and spreading, the heat of the grain is equalized and regulated. The growing is interrupted when the roots have reached the length of 1 1-3 to 1 2-3 of the kernel, and when the cotyledon has advanced 1-2 or 2-3 into it. If the germination be allowed to go on, both starch and diastase would be used up by the young plant to construct its cellular tissue.

The annexed engraving shows the grain during the several stages of germination, Fig. 1 representing the natural grain; Fig. 2, the grain swelled by moisture; Fig. 3, the starting of the germ; and Fig. 4 shows the condition of the grain when germination is arrested by drying. By transferring the grain from the malting floor to the malting kilns (shown on this page) the germination is arrested. Here it is submitted to the currents of hot air generated in the furnaces below. If carefully dried the malt retains its properties for a number of years and may be used in brewing at any time.



BARLEY GRAINS.

Malting and brewing are separate and distinct businesses and may be conducted independently of each other.

In the brewery, the malt is freed from the sprouts, crushed in mills, and mixed with hot water in the "mash tub," shown in the left hand view on this page. By the action of the diastase the starch of the malt is changed into glucose and dextrine. The latter two together with a quantity of albuminates are dissolved and drawn off through the perforated bottom of the mash tub, while the husk of the malt and some unconverted starch remain.

The saccharine liquor, called wort, is conveyed into kettles, one of which is shown in the upper left hand view on the front page, where it is charged with hops and boiled for a number of hours. From the kettles it passes through strainers, called "hop jacks," which retain the hops and coagulated albumen, to the coolers and refrigerators.

When cooled to the required temperature the wort enters the fermenting tubs, shown in the upper right hand view in the larger engraving, to be yeasted. Here the fermentation takes place. Through the action of the yeast a part of the saccharine matter is decomposed into alcohol, which remains, and carbonic acid gas, which escapes into the air.

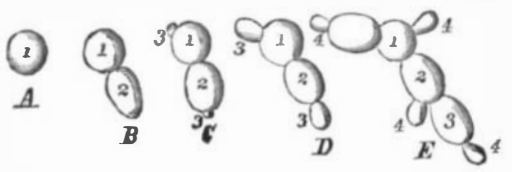
The attack of the yeast upon the beer manifests itself by the reduction of its specific gravity, the alcohol being lighter than the glucose, which it replaces. By observing the changes in that respect it is ascertained whether the progress of the fermentation is to be checked or increased. What is known as stormy fermentation may reduce the density too much, while too slow a fermentation might leave too much of the glucose unchanged.

As soon as the fermentation is finished the beer is transferred to the racking tubs, shown in the lower portion of the title page engraving, where, after having settled, it is drawn into barrels.

It is a peculiarity of ale that, unlike sugar or distilled liquors, it can never be corrected if once spoiled, and that it has and retains the character of the material from which it is made. By additional labor and cost a marketable sugar or liquor may be obtained from poor raw material, but a good ale can only be made from perfect malt and hops, however complete the method of brewing may be. On the other hand the finest malt will turn out a poor ale if the manufacture is trusted to mere guesswork or "rule of thumb."

Brewing, from malting to fermenting, forms one continuous line of the most complicated chemical processes, and it requires a full acquaintance with the nature of these processes to keep them under control, to distinguish the important from the unimportant, and to make use of new discoveries. Any changes of the water or temperatures in malting or mashing alter the chemical composition of the wort. The proportions between glucose, dextrine, albumen, and phosphates become disturbed and an ale of a different character will result.

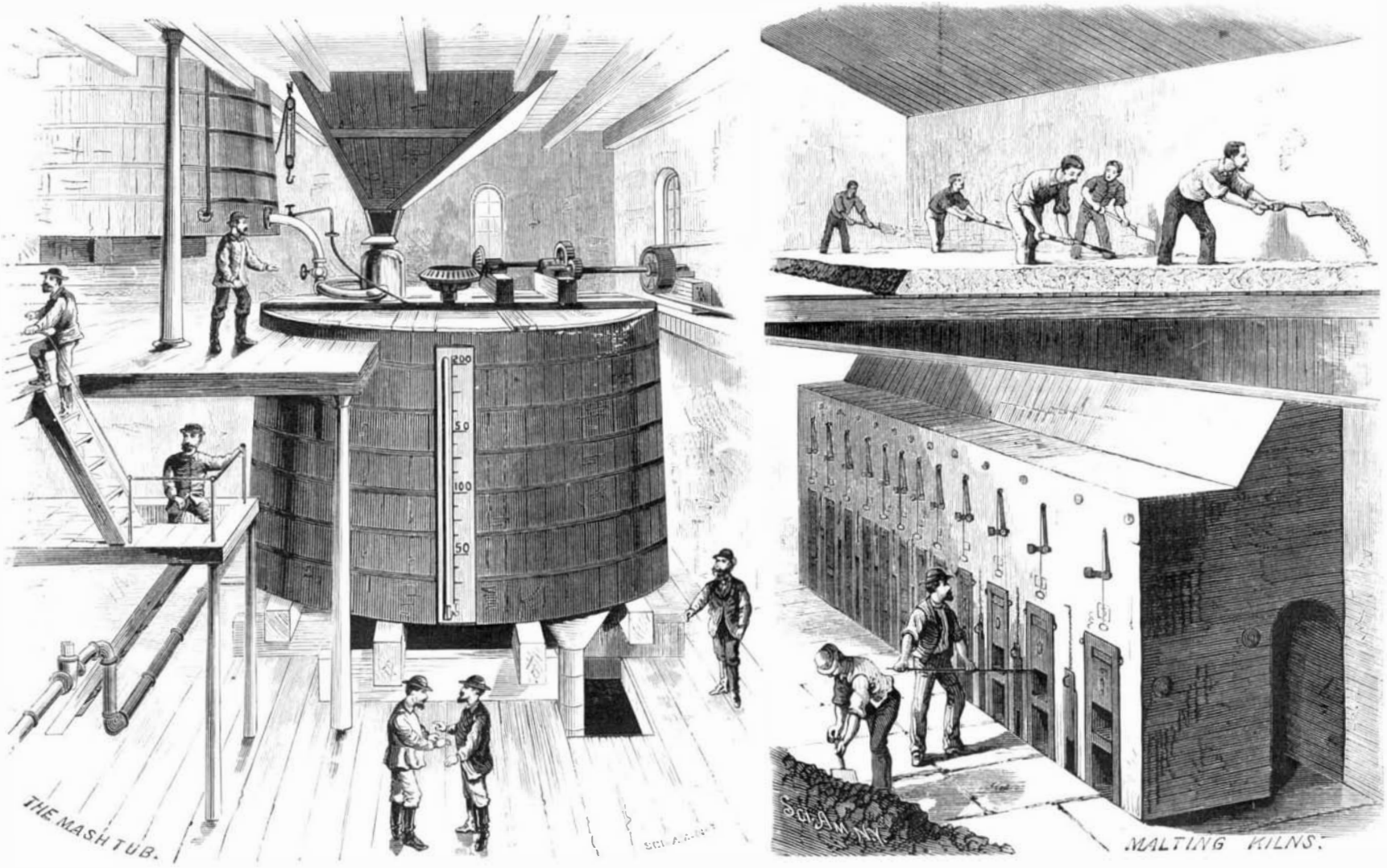
The development of the delicate yeast cell is affected by the slightest change of temperature, and, like other plants, it is subject to degeneration and parasites.



DEVELOPMENT OF THE YEAST PLANT.

The great progress which Messrs. Ballantine & Sons have made in the manufacture of ales is solely due to their steadily pursued efforts to place their business upon a true scientific basis by making the best use of the discoveries and researches (into fermentation, etc.) of Cagniard-Latour, Liebig, and Pasteur.

M. S. MESINIER has made mixtures of iron and nickel chlorides, reduced by hydrogen at a red heat, yield well defined alloys, sometimes admirably crystalline, and closely analogous to the meteoritic alloys of iron and nickel.



THE MASH-TUB AND MALTING KILNS.

Sugar in the Northwest.

Several promising experiments have been made during the past season with the early amber sugar cane, which is said to thrive as far north as Massachusetts and Minnesota. The chemist to one of the largest sugar refineries of St. Louis, Mr. Henry Studniczka, says that Minnesota is especially suited for the cultivation of this plant.

An acre of land will readily produce eleven tons of cane, and a ton of cane will give from 85 to 95 gallons of juice by the use of a sixteen horse power mill.

The juice contains 16 per cent solid matter, 13 parts of which are crystallizable sugar, and the remaining 3 parts being invert sugar and organic matter. An acre of cane will safely produce 130 to 150 gallons of sirup of 80 per cent density.

Out of the 130 to 150 gallons of sirup per acre there can be made, by using proper machinery, 1,000 pounds of sugar, and what is left, about 60 gallons, will be a fine article of molasses.

Mr. Bowen, of Litchfield, Ill., cultivated 80 acres of the amber cane last season.

The cane grows from 10 to 11 feet tall, and each stalk, stripped and headed, weighs from 2 to 3 pounds. A man can, with ease, cut 2 acres per day. Two boys, each using a common lath, can strip an acre per day. A team can haul it up in the same time.

For a mill grinding 3 acres in twenty-four hours, will be required three men and a horse, besides two or three boilers.

From the mill the juice should pass into large settling vats, where impurities are taken from it. From here the juice passes into the large clarification pans, where the necessary chemicals for purifying can be applied. When well heated and skimmed, the juice passes into the evaporating pan, from which, if it is desirable to make sugar, it is turned into wooden coolers for crystallization. When crystallized the sugar can be separated from the sirup either with a centrifugal machine or by drainage.

The outfit for a six horse power mill, grinding about 3 acres per day, is 2 or 3 clarification pans, about 12x3 feet and 8 inches deep, and 1 evaporator for finishing. Another filtering of the juice, as it passes from the clarification pans to the finishing evaporator, is of great advantage. Skimmings can be made use of in fattening hogs. The skimmings of the finishing evaporator produce a fine quality of vinegar.

The seed of the amber cane is a good article of food for stock.

The refuse should be composted and returned to the soil, as the sugar in the cane is a product of the atmosphere, containing oxygen, carbon, and hydrogen in equal proportions. Thus the farmer will return to the soil all which the cane takes from it, and consequently this crop will prove far less exhaustive to his land than wheat or other grain.

THERE is to be a grand National Exhibition held in Moscow, Russia, in 1880, which will be accompanied by festivities of no ordinary kind. It coincides in point of time with the 25th anniversary of the Emperor Alexander's accession to the throne.