Starch. Starch and cotton goods originated in the East. The institutes of Menn, 800 B. C., refer to the stiffening action of starch on fabric.

Pliny informs us that starch was prepared from wheat by the inhabitants of Chio. The method of starching linen was publicly taught in England in the year 1560 by a Dutch woman, a Mrs. Dingham, the wife of Queen Elizabeth's coachman. She charged £ 5 for showing the process, and £ 1 extra for showing how to manufacture the starch. This was 260 years before Beau Brummel, who made his grand début in starched cravats.

Starch is found in the cells of all plants except fungi, in the form of minute granules, varying in diameter from $^1/_{240}$ to $^1/_{4000}$ of an inch. It is composed of 24 parts carbon and 20 each of oxygen and hydrogen, being nearly identical in composition with cellulose, into which it is charged by heat or the action of sulphuric acid. Its color is changed to a deep blue by iodine, which thus serves as a delicate test of its presence.

The granules are separated from the gluten and other principles by washing, and form an insoluble precipitate, being only mechanically suspended in the water. When dried and examined through the microscope, they are found to be made up of concentric layers, and appear beautifully colored under the influence of polarized light. Though constructed on one general type, the granules obtained from each kind of plants have in general peculiar characteristics, by which their origin may be readily determined.

Those from the potato are among the largest, while those of the cereals generally are much smaller. The granules of arrowroot resemble those of the potato, but are somewhat smaller.

Treated with dilute sulphuric acid, or heated to 300° Fah., starch is converted into dextrine, or British gum, which is largely employed as a cheap substitute for gum-arabic. By farther ebullition with the dilute acid, this substance is transformed into glucose or grape-sugar. See DEXTRINE; SUGAR.

The same process occurs in the germination of seeds by the action of the peculiar substance called *diastase*, into which the albumen of the seed is converted under the influence of warmth and dampness. The same action takes place in the process of malting.

In England, wheat is generally used for making starch, the ordinary process being as follows: —

The grain, crushed between rollers, is thoroughly wetted and allowed to stand for 4 or 5 days, until fermentation takes place; it is then removed to a vat, where more water is added, and allowed to ferment for from 2 to 3 weeks, when the mass is transferred to a stout basket, where it is washed by a continuous stream of water, and at the same time stirred with a shovel until the starch is completely separated from the bran.

It is received in a *back* or vat beneath, from whence it is taken and strained through hair-sieves into cisterns, where it is allowed to settle for 24 hours, after which the water above is decanted by tap-holes at different levels in the side. The upper part of the deposit, termed *slimes*, is removed, and the lower and impure starch is again agitated with fresh water and passed through a finer sieve; when the starch has subsided again from the strained liquid, the latter is drawn off, the second *slimes* are removed, and the remainder is again agitated with water and passed through the sieve. It is now allowed to become solid by evaporation, a little smalt or artificial ultramarine added to give it the required bluish tint, and any trace of acid removed by the addition of an alkali; while still moist it is shoveled into boxes lined with fine canvas, and having perforated bottoms. When tolerably dry it is cut into pieces 5 or 6

inches square, partially dried, and finally stoved to render it completely so.

In this country, Indian-corn and also potatoes are very generally used for making starch: potatoes are prepared by thoroughly washing and then crushing in clear cold water; the resulting starchy matter flows into vats beneath, where it is allowed to settle, and is afterward washed one or more times, dried in stoves and packed; the refuse of the potatoes, the pomace and skins, being carried off by a current of water. These factories are small, and only operate during the latter fall and early winter, requiring as they do plenty of cold water, fermentation in this case being inadmissible.

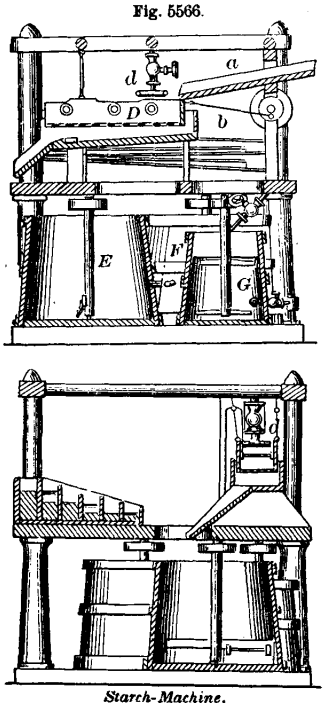
The application of maize to this purpose was patented by James Coleman in 1841, and was successfully practiced in the ensuing year at Oswego, N. Y., by Thomas Kingsford. The Kingsfords at present have probably the largest starch factory in the world, having bins five stories in depth, capable of holding 2,000,000 bushels of corn, and turning out annually some 4,000 tons of starch.

From the bins the grain is passed through fanning-mills, which remove impurities, and is then conducted to large vats, where it is macerated and softened to facilitate the separation of the albumen and gluten. After this process it is ground and pulped by a series of burr stones and heavy iron rollers, and is next transferred to drums or sieves, where the starch is washed out by the action of water, the non-farinaceous portion remaining within the sieves being finally allowed to escape through openings at their ends and conducted away to receptacles, whence it is taken and used as food for cattle.

The starch is received in vats, where it is agitated by means of stirrers operated by water or steam power, and is supplied with water and chemicals to purify it. When the superfluous water has been partially withdrawn, and it is in a semi-fluid state, it is run into molds, where it settles into solid cakes, which are broken into square cakes; these are placed in a kiln and dried at a low heat, and the cakes are scraped to remove impurities, which appear as a yellow crust on the surface. They are now again dried, causing them to fall into little pieces, which assume the peculiar forms so well known. They are then packed into barrels or boxes, according to quality. The highest grades, as corn-starch for puddings, or *maizina*, being ground fine, measured, and automatically put up and pressed in the packages by an arrangement of devices which prevent wastage and obviate the production of dust.

Various forms of apparatus are used for washing out and drying the fecula; the general principles of all, however, being similar.

Fig. 5566.



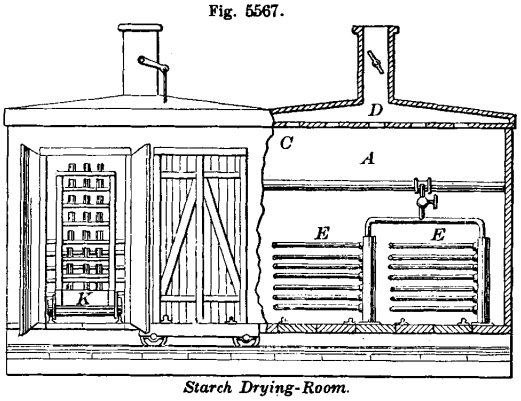
Starch-Machine.

In the apparatus (Fig. 5566), the pulpy mass passes from the trough *a* to the vibrating separator *D*, having at bottom a bolting-cloth, and supplied with water from a pipe *d*; the feculous matter is received in a vat, as *E F*. After settling, the water is drawn off and caustic alkali added. The contents of the vat are then agitated and transferred to a winding, inclined trough *b*, where the starch is deposited while the gluten is dissolved by the alkali The starch is then transferred to another vat, as *G*, agitated and washed with water, after which it is again allowed to settle, drained and dried.

The drying-room (*A*, Fig. 5567) is provided with a series of racks *K*, has ventilating openings *C D*, and is heated by pipes *E E* The cakes of starch are conveyed to the chamber by trucks running upon tracks and transferred to the shelves.

An incombustible starch, according to Hager, is made by pouring 50 parts hot water upon 10 parts pulverized burned bones, and adding gradually 6 parts sulphuric acid. The mix-

Fig. 5567.



Starch Drying-Room.