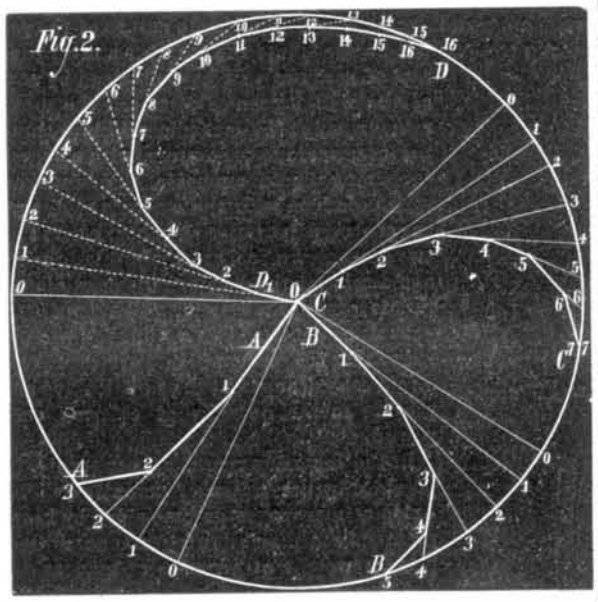
the man walks three times as fast as the horse. This is represented in Fig. 2, in which the track of the horse is divided into spaces each equal to $\frac{1}{48}$ part of the circumference. At A A, each part of the man's track is made equal to three times that length; and it is seen that, before the horse has accomplished three of these divisions, or one sixteenth of the circumference, the man will have overtaken him along the line, 0, 1, 2, 3. At B B, the case is represented that the man walks twice as fast as the horse; the engraving shows that,



before the horse has accomplished five divisions or one tenth of the circumference, he will be overtaken. At C C, we represent the case that the man walks one and a half times as fast as the horse, the distances from the center, 0, 1, 2, 3, being one and a half times the corresponding $\frac{1}{48}$ part of the circumference. It is seen here that the horse will have been overtaken when he has passed over seven spaces, or $\frac{1}{7}$ of the circumference. Finally, at D D, we have represented the interesting case that the man walks exactly as fast as the horse; it is seen that, after going through sixteen spaces, or $\frac{1}{3}$ of the circumference, the man will move very nearly in the circumference, but always nearly one space ($\frac{1}{48}$ of the circumference) behind the horse, without being able ever to reach him. All that he then can do is to stop and let the horse overtake him.

SOURCES OF EDIBLE STARCH.

Besides the well known cereals, the number of plants producing starch, in root, stem, or fruit, in quantity sufficient to make their cultivation profitable, is very large. The number made use of in supplying the starches of commerce is comparatively small. Not more than a dozen contribute largely, and the excellence of these is clearly due in great measure to long cultivation. With the increasing demand for farinaceous foods, and the development of agriculture in tropical countries, where starch-producing plants chiefly flourish, many other starch yielders will doubtless be brought under cultivation, with as marked an improvement in their quality and productive value, we may expect, as the cereals have shown, or, more notably, the potato.

Possibly the effect upon the cultivators may be equally important. The cereals have been to a great extent both the occasion and the means of raising agriculture to its high position in temperate climes. In like manner the development of tropical and sub-tropical communities must come largely through habits of industry and thrift acquired in systematic agriculture, in which the starch-producing plants must play the same part the cereals have in colder regions.

The arrow root of the West Indies (*maranta arundinacea*) furnishes the standard quality and the common name for farinaceous products. Starch is starch the world over, and its composition is the same, whatever its source. The commercial starches are more or less impure, more or less flavored by the elements with which they are associated in Nature, and which are not perfectly eliminated in the process of manufacture. There is a difference also in the size of the granules, but this requires the microscope to determine. Arrow roots contain about 25 per cent of starch, which is extracted by a process of grinding, rasping and washing the pulp with water.

Owing to careful preparation and the purity of the water used, Bermuda arrow root has the name of being the purest and best in market; but an equally fine quality is now furnished from other localities, St. Vincent taking the lead both in quantity and quality. In Bermuda, as in most of the West India islands, the amount produced has greatly decreased of late years, the cultivation of early vegetables for our city markets offering larger profits.

In the Bahamas and other West India islands, and in Florida, a starch much resembling true arrowroot is obtained from the roots and stems of certain species of zamia. In Florida they are called *conti* roots, and the farina prepared from them *conti*. In the shops it is known as Florida arrow root. Another West Indian starch, called *tous le mois*, characterized by the relative coarseness of the granules, comes from several species of *canna*, one of which, *canna edulis*, has been largely introduced into Australia, where it yields an excellent quality of starch.

A great number of starch-yielding plants are employed for local use in South America; but for exportation the West Indian *maranta* and the native *manihots* are chiefly cultivated. There are two species of the latter (*manihot utilissima*), otherwise known as cassava root, being bitter and poisonous, the other (*m. api*) sweet, and largely used as an esculent, simply boiled. Both have been extensively introduced into other parts of tropic America, the East Indies, and the coast of Africa. The tubers of the bitter species, which is most extensively cultivated, sometimes attain the length of three feet and weigh thirty pounds, the milky juice being removed by pressing and the poisonous principle expelled by the action of heat. When heated in a moist state, the starch is partly cooked, forming small, hard, irregular masses, the tapioca of commerce. Like the potato, the manihot has developed a large number of varieties under cultivation, differing as potatoes do in quality and period of maturing, some coming to perfection in six months, others requiring a year or more. Farina of manihot, both in its crude state and made into thin cakes, is very largely eaten in Venezuela and Brazil, where the manihot is most cultivated, the single province of Santa Catharina having as many as 14,000 establishments for its manufacture.

The bulbous root of another poisonous South American plant, a climber, furnishes the starch called *jocatupê*, said to have important medicinal properties. Only a small quantity is produced.

The African arrow roots are of various origin. The Cape Verde islands export a considerable quantity, chiefly extracted from the Brazilian cassava root. St. Thomas, Angola, and Mozambique also yield a small amount. In Liberia, Sierra Leone, and other African colonies, especially Cape Colony and Natal, the true arrow root (maranta) has been largely introduced, and the prepared starch is beginning to be exported in noticeable quantity. Madagascar and the Mauritius likewise yield a small amount.

In 1840 the maranta was brought to Madras, and shortly afterwards to several other East Indian countries, where it thrives abundantly, developing in from twelve to fifteen months. With good irrigation, a year suffices to secure the maximum yield of starch, 16 per cent. More recently the same plant, together with the manihot, has been introduced into Ceylon, where after much persuasion the natives have been induced to cultivate them. Now the amount produced not only supplies the large local demand, but allows of considerable exportation.

What is known as *tikor*, or East Indian arrowroot, comes from the roots of a native plant, the narrow-leaved turmeric (*curcuma angustifolia*), which abounds in Ticor, Benares and Madras. A large part of the diet of the inhabitants of Trevancore is the starch of another plant of this genus, while still another answers the same purpose in Berar. In Chittagong, a wild ginger plant, growing everywhere in such profusion that it is almost a nuisance, has a root loaded with starch of a good quality. The supply of the root is inexhaustible; and with a little trouble in digging and preparation, it might be made to furnish a vast quantity of cheap and nutritious food. Other less known plants supply a large amount of starch for local use in India, notably a wild arrow root which grows in the jungles. The starch is of excellent quality. In many other parts, the natives also lay under tribute for the same purpose the young roots of the Palmyra palm, which are rich in starch. At Goa, a farina is prepared from the wild palm, and in Mysore from the sago palm of Assam (*carryota urens*) which yields a sago little if at all inferior to that of the true sago palms of the Malay countries. Less nutritious and palatable sagos are also obtained from the Talipat palm in Ceylon, and the *Phœnix farinifera* which grows on the Coromandel coast.

The most generous of starch producers, however, are the true sago palms, of which two species (*sagus konigii* and *sagus lævis*) are chiefly cultivated. Though most abundant in the eastern parts of the Malay archipelago, these palms are found throughout the Moluccas, New Guinea, Borneo and the neighboring islands, and as far north as the Philippines. The yield is immense, three trees affording more food matter than an acre of wheat, or six times as much as an acre of potatoes. As the trees propagate themselves by lateral shoots as well as by seeds, a sago plantation is perpetual. Wallace shows that ten days' labor or its equivalent in money will put a man in possession of sago cakes, the principal if not the sole food of the natives, enough for a year's subsistence. A single tree contains from twenty-five to thirty bushels of pith, which, with a little breaking up, will yield from six to eight hundredweight of fine starch.

Upwards of 20,000 tuns of sago pith are annually converted into commercial sago by the Chinese at Singapore. The finer quality, known as pearl sago, is prepared in great quantities by the Chinese of Malacca, something like 250,000 hundredweights being sent therefrom to England alone. The manufacture of tapioca is also largely carried on at Singapore and at Penang, 75,000 hundredweight being sent to England annually from the former port, and 10,000 from the latter.

Japan sago is made from the pith of a fern palm (*cycas revoluta*), which yields a large quantity of sago-like starch.

Another starch-yielding plant, now extensively cultivated in the East, is the *tacca pinnatifida*, known throughout the South Sea islands as *pia*. The tuberous roots resemble potatoes, and are largely eaten in China and Cochin China. When raw, the tubers are intensely bitter and acrid, but these objectionable qualities are removed by cooking. The starch is of fine quality, much valued for invalids, and the yield is liberal—30 per cent. The South Sea tacca grows on high sandy banks near the sea, and yields a starch equal to Bermuda arrow root, when carefully prepared.

In other Pacific islands, certain species of aurum are also utilized for starch, the one most extensively cultivated (*aurum esculentum*) being known as *taro*. The natives of Tahiti distinguish thirteen varieties, doubtless the result of artificial selection. The tubers, which weigh from two to four pounds, each yield as much as 33 per cent of starch, combined with a blistering bitter principle which is destroyed by heat. Our familiar Indian turnip, with its acrid flavor belongs to the same family of plants.

Among the other starch-producing plants, extensively cultivated for food in tropical countries, and which are destined to add immensely to the food supply of colder climates, are yams, bread fruit, and bananas, including the variety known as plantains. The last fairly rival the sago palm in affording the maximum amount of food for the minimum amount of labor. The yield to the acre is, in bulk, forty-four times that of potatoes, and the proportion of starch is somewbat greater. The fruit is also richer in other elements of nutrition, so that the meal prepared by drying and grinding the plantain core resembles the flour of wheat in food value. It is easily digested, and in British Guiana is largely employed as food for children and invalids. The cost of preparing plantain meal cannot be great, and the supply might be unlimited. The proportion of starch is 17 per cent; in bread fruit it is about the same; in yams it rises to 25 per cent, but is hard to extract, owing to the woody character of the roots.

FAILURE OF PATENT EXTENSION SCHEMES.

We are glad to be able to state that the Senate Committee have agreed to report adversely upon the application of the sewing machine monopolists, for extensions of the Wilson, Aikens and Felthausen, and Wickersham sewing machine patents.

Adverse reports are also announced on the Tanner car brake, Rollin White pistol, and Atwood car wheel.

The following cases were deferred until next session: Norman Wiard's boiler attachment to prevent boiler explosions, and Butterworth's patent burglar-proof safe.

SCIENTIFIC AND PRACTICAL INFORMATION.

RESPIRATION OF PLANTS.

Vegetables, it is well known, exhale carbonic acid in the dark. M. Deherain states the curious fact that if a certain mass of vegetables thus acting be compared with a like mass of cold blooded animals, the exhalating energy will be found to be the same in both cases. This is another of those odd coincidences which seem to level the distinction between the two great organic kingdoms.

DIFFUSION BETWEEN MOIST AND DRY AIR THROUGH POROUS EARTH.

If a partition of porous earth separates two gases of different densities, an unequal diffusion takes place across the dividing body; the current of denser gas is more abundant than the other. M. Dufour has recently investigated the question as to what takes place when two masses of air of the same temperature, but containing unequal quantities of water, are substituted for the gas. He finds that there is still unequal diffusion, and that the most abundant current passes from the dry over to the moist atmosphere. This diffusion depends on the tensions of the aqueous vapor on the two sides of the porous partition.

GAS LIGHTING BY ELECTRICITY.

A new pneumatic gas lighting apparatus, now being introduced by Mr. Asahel Wheeler, of Boston, Mass., was recently tested at Providence, R. I., with satisfactory results. A current of compressed air is transmitted from a central engine to diaphragms at the burners, the moving of which turns on the gas, which is then lit by an electric spark. Forty lights were kindled and extinguished simultaneously with great rapidity. It is stated that by this device all the street lamps in a city may be lit by the movement of a single lever, at any certain point.

BEER.

The National Brewers' Congress recently met in Boston, Mass., and from the report of the proceedings, we glean the following statistics of the industry in this country. A steady increase in the consumption of beer of a million barrels per annum shows that, the more people drink, the more the appetite for drink increases. The capital invested is stated as $89,108,230; 1,113,853 acres of land are required to produce the barley, and are cultivated by 33,753 men; 40,099 acres are devoted to hop culture, requiring the work of 8,020 people; and 3,566 hands are employed in the malthouses.

MILK FROM SWITZERLAND.

The American process of condensing milk, invented by the late Gail Borden, of Texas, has been everywhere copied in Europe. Large works have been erected in Switzerland, and cows that feed in the finest Alpine pastures now furnish excellent milk for the city of New York. The agents are Messrs. Dudley & Co., 153 Chambers street.

EVERY condition in life has its advantages and its peculiar sources of happiness. It is not the houses and the streets which make the city, but those who frequent them; it is not the fields which make the country, but those who cultivate them. He is wisest who best utilizes his circumstances, or, to translate it, his surroundings; and happiness, if we deserve it, will find us, wherever our lot may be cast.

In the proposed railway up Mount Vesuvius, the engine, which is fixed at the bottom of the plane, sets two drums in motion, round which the metallic cable is wound, by means of which the trains are drawn up and let down simultaneously.

A railway train lately arrived at Algiers, Africa, from Oran six hours behind time, the cause of the delay being that the rails were covered with a thick layer of locusts.