will remove any chromium salts still remaining in it, and will also press down the loose film uniformly upon the glass surface. Finally, the plate is allowed to dry in a perpendicular position. Further treatment of the plate with varnish follows as a matter of course.

The image upon the collodion film is very thin; but you need be under no apprehension of its tearing while in the water, when it may be easily manipulated. I have to do with films of this kind measuring three feet square.—*J. B. Obernetter.*

NEW ANTIDOTE FOR ARSENIC.—The only antidote for arsenic heretofore known has been hydrated peroxide of iron, which must be freshly made by mixing carbonate of soda or potash with a solution of either sulphate (copperas) of iron or muriate. A French experimenter, M. Carl, says that sugar mixed with magnesia serves as an antidote for arsenious acid.

IN Europe the multiplication of photo prints is extensively done by mechanical means, with printing ink, and the copies, equal or superior to silver prints, are supplied at half the cost of the latter.

Scientific American.

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Contents:

(Illustrated articles are marked with an asterisk.)

THE END OF VOLUME XXX.

The thirtieth volume of the present series of the SCIENTIFIC AMERICAN closes with the present issue, and, completed, joins its predecessors as another milestone, recording the progress made by mankind in the path of Science during the six months which have just passed. It is hardly necessary to point out that, in the pages now finished, it has been our endeavor, as it will be in those to come, to popularize scientific knowledge, and to make the same generally available to the masses; not aiming to supply information valuable alone to the engineer, to the chemist, or indeed exclusively to any profession or calling, but rather to glean from the whole broad field of Science and Art the richest sheaves of genius, and to present, winnowed therefrom, the kernels of wisdom, unmixed with the chaff of technicality and abstruseness. That such a course has met the public approval, our increasing circulation and the many letters of which we are constantly in receipt, offering us pleasant wishes of encouragement, are the best and most flattering evidence.

In glancing back over the contents of the past volume, we feel that we may confidently assert that in no other periodical now extant is there to be found a wider range of topics, treated in popular and readable form, the perusal of which will add more largely to the stock of valuable knowledge of any reader.

In the pages now closed we have presented 258 illustrated subjects, in many cases with not merely a single cut, but with a series of engravings. These embrace the most recent mechanical inventions, patented in this country and abroad—new steam engines and boilers—new weapons of war—new tools for every variety of industrial employment—new household implements—new machinery of every kind for especial purposes—illustrations of new scientific experiments—views of new buildings, bridges, and monuments—pictures of rare and new plants, fossils, and animals—of queer freaks of Nature in the animal and mineral world—lucid diagrams, explanatory of mathematical demonstrations, and new theories of natural phenomena.

As for miscellaneous information, we would refer the reader to the columns of fine type, attached to this number, which form the index, in order to gain an idea of the number and variety of the matters he has examined.

No great discoveries have been made during the past six months; but the progress of Science has been uniform, and stopping, as we now do, for a momentary breathing spell, we can look back and see a notable advance. Professor Thurston has sent us a large amount of important and valuable news regarding the behavior of metals under stress, and how to test them—facts of the liveliest interest to every engineer and mechanic. Professor Orton has continued his letters, telling us about the little known resources of Central South America. In astronomy, we have presented our monthly notes, regarding positions of planets, times of phenomena, etc.; abstracts of Professor Proctor's excellent lectures during his late visit to this country, and also an account of Professor Wright's discovery of the cause of the zodiacal light. We have also noted the discovery of new planets and comets, announced the donation of $700,000 by Mr. James Lick, of San Francisco, for a gigantic telescope, and illustrated an ingenious plan for the manufacture of that great instrument, the device of Mr. Daniel Chapman. Our abstracts from the proceedings of the British Association, the French Academy of Sciences, and our own scientific associations, have been very full and accurate, while reducing the new topics discussed for ready comprehension by every one. Engineering subjects have been so extensively treated that it is hardly possible to particularize. We have illustrated the 1,000 foot tower proposed for the coming centennial, called attention to new processes of tunnel boring, bridge building, and railroad construction, mentioned some important works in hydraulic engineering in the West, and, in a multiplicity of articles from the pens of expert writers, considered topics of a timely and lively interest to the profession. Chemical matters have received their full share of attention, and so also the important subjects of electricity and magnetism, in which notable advances have been made.

With the end of this volume many subscriptions expire, which we hope to see speedily renewed. In accordance with our rule, the paper is not sent after the subscribed-for term has expired; so that those who have failed to remark the notice on the wrappers of the copies received lately will be warned, by the cessation of our visits, that the time has come for them once more to express their appreciation of our efforts by sending us their substantial support.

HOW TO ATTAIN HIGH TEMPERATURES.

In his recent interesting address before the *Société des Ingénieurs Civils*, M. Jordan spoke at some length of the methods now adopted of attaining high temperatures in metallurgical operations, and of the bearing of chemical principles and recent discoveries upon the subject. The learned engineer speaks of the "duel," as he terms it, between the fire on the one hand and the refractory materials used in the arts on the other, and recognizes the serious difficulties which impede the effort to utilize high temperatures, when it is possible to attain them.

The Siemens regenerative furnace and its modifications represent the most successful means yet in general use for producing extremely high temperatures, and the difficulty most frequently met is that of finding fire brick or other material capable of withstanding the heat of the ignited gases We have known of instances in which the lining of steel-melting furnaces has been melted down like wax before this tremendous heat. Assuming, however, that we may expect to find sufficiently refractory materials to permit the utilization of still higher temperatures, the problem, to determine how to reach a higher limit, presents itself.

Under ordinary conditions, we cannot much exceed the temperature of a steel melting furnace, since dissociation occurs at a temperature supposed to be in the neighborhood of 4,500° Fah., for oxygen and hydrogen; consequently all combustion must be checked at some lower point on the scale, so long as no external force aids that of chemical affinity. The temperature of dissociation of carbonic acid is even lower than that for hydrogen and oxygen, and is shown to be not far from 2,500° Fah. Finally the presence of nitrogen in atmospheric air reduces the maximum temperature attainable, by furnishing a mass of gas which, while itself adding nothing to the supply of heat, abstracts (from the heat supplied by combustion of carbon and hydrogen) the larger amount required for its own elevation to the temperature of the furnace.

Elevation of the limit to increase of temperature of furnaces may be obtained by elevating the temperature of dissociation, and this, it has been found, may be done by producing combustion under pressures exceeding that of the atmosphere. Mr. Bessemer, the well known inventor who so nearly antedated our countryman Kelly in the invention of the pneumatic process of manufacture of iron and steel, which is generally known as the Bessemer process, has patented a method of increasing the pressure under which such operations occur. In the ordinary pneumatic process, this increase of pressure occurs to some extent in consequence of the small area of the opening by which the gases leave the converter, and it is stated that the pressure within the converter sometimes becomes double that of the external atmosphere. We may doubt if the increase ever becomes so great as this; yet there can be no doubt that it is sufficiently great to have an important influence in elevating the limit of dissociation and in giving the very high temperature which holds nearly pure iron within the converter in a condition of fluidity never observed elsewhere.

It is readily seen that the conclusions of M. Jordan, in the address to which we alluded above, are justified both by Science and by practical experience. He advises: The choice of a combustible which may be consumed in a bath of metal furnishing a non-volatile residue without injuring (*sans dénaturer*) the metal, and the adoption of a form of furnace which, heated by gas or otherwise, may be worked with an internal pressure of several atmospheres. He refers to the marvelous discoveries, recently made, relative to temperature and pressure on the surface of the sun and other heavenly bodies as affording illustrations of the possibilities in the direction of attaining high temperatures.

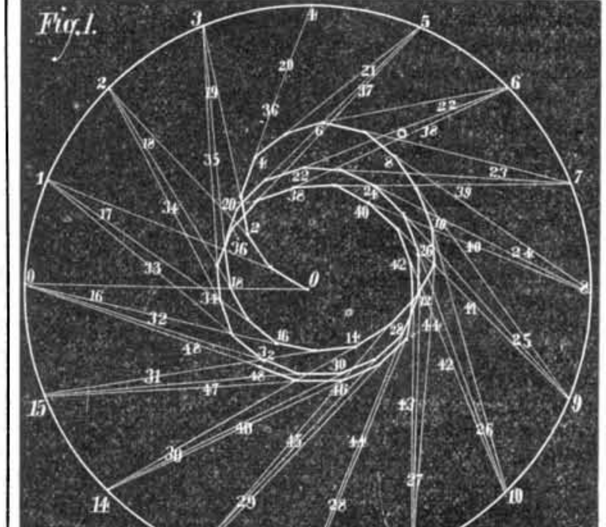
The problem presented is as interesting and attractive as it is important; and the inventor of new methods or of perfected apparatus, and the discoverer of more refractory materials than those now used, will aid greatly in its solution. Powerful intellects and ingenious minds are at work upon it; and we hope that our readers will be able to find in our columns evidence that the ingenuity which has made our people famous as a nation of mechanics, and the growth of Science which is gradually becoming so noticeable among us, have assisted to a valuable extent in effecting so important an advance in this direction. Any improvement or discovery which assists in the production and the economical application of high temperatures aids every branch of industry, and promotes our material welfare in an inconceivable number of ways.

A CURIOUS PROBLEM.

In our queries of last week's issue a correspondent, B. F. B., says: "There is a problem, which some one has found in a work published many years since, which is as follows ' A man, at the center of a circle 560 yards in diameter, starts in pursuit of a horse running around its circumference at the rate of one mile in two minutes; the man goes at the rate of one mile in six minutes, and runs directly toward the horse, in whatever direction he may be. Required the distance each will run before the man catches the horse, and what figure the man will describe.' I hardly think it admits of a solution under the above conditions; but were they reversed, that is, if the man were running at the rate of one mile in two minutes, and the horse one mile in six minutes, what would the answer be?"

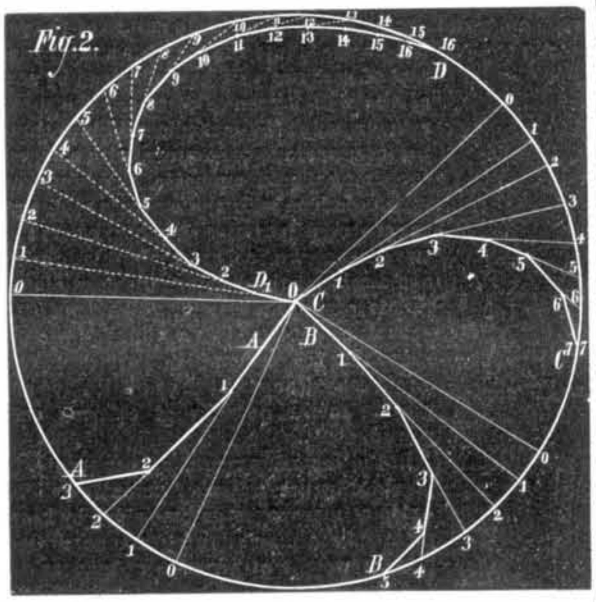
This problem gives rise to an interesting investigation of a curve, which at first sight appears to be similar to the spiral of Archimedes, but on further examination proves to be totally different. The spiral of Archimedes is the track of a point which moves with uniform velocity along the radius from the center to the circumference, while, at the same time, the end of the radius travels round the circumference. In this problem, however, the point moving from the center does not move uniformly in the direction of the radius, but more and more obliquely toward a uniformly progressing point in the circumference, giving rise to an intricate application of the differential calculus, which finally proves that the man will never reach the horse, but that the curve described by him will, after three revolutions of the horse, be nearly identical with a circle, the circumference of which he will approach more and more, and of which the radius is one third of that in which the horse moves. The most interesting fact revealed, however, is that, if the velocity of the man is half that of the horse, he will, after two revolutions, be near the circumference of a circle of half the radius of the outer one; and when he moves with one fourth the velocity he will, after four revolutions, be very near a circle of one fourth the size, and so on.

In order not to burden our readers with extended calculations in the field of the higher algebra, we have solved the problem in the graphic method. In our first figure we hav



divided the circumference of the circle into sixteen equal parts, 0, 1, 2, 3, 4, etc., and taken one third of such a part and set it out on the radius from the center, 0 to 1. While the horse has moved along the circumference from 0 to 1, the man will have traveled from the center 0 to 1; while the horse is traveling from 1 to 2, the man will have traveled along the line 1, 2, 2; while the horse travels from 2 to 3, the man will travel in the direction 2, 3, 3, and so on; the only difference between our engraving and the reality being that the short lines representing the road traveled by the man will be slightly curved, instead of straight as we have represented them. By making these lines smaller, we may come sufficiently near to the reality, but the final result will not essentially differ. If the reader follows the different tracings for three revolutions, as represented here, he will see that finally the man will walk in a circle one third the size of that in which the horse moves, and will constantly see the horse in a direction tangential to the circle in which he walks; and therefore he never can reach it if he always moves directly toward the horse.

It is quite otherwise when the problem is reversed, and 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 Travancore 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 lœvis*) 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 somewhat 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.