of minute division. After the ware is ornamented, it is inclosed in a muffle furnace, shown in Fig. 10. This consists of an inner box of fire brick, which is so arranged as to be completely surrounded by the products of combustion. After the colors are developed the articles are removed, and hand-burnishing of the metallic portions completes the manufacture.

Scientific American.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT

NO. 37 PARK ROW, NEW YORK.

O. D. MUNN. A. E. BEACH.

TERMS.

One copy, one year, postage included.....$3 20
One copy, six months, postage included..... 1 60

Club Rates:

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VOLUME XXXII., No 13. [NEW SERIES.] *Thirtieth Year.*

NEW YORK, SATURDAY, MARCH 27, 1875.

Contents.

(Illustrated articles are marked with an asterisk.)

FROZEN PIPES AND HYDRANTS.

This year the winter has been really one of the kind that are only equaled in the memory of the oldest inhabitants. In some places not far from New York, we hear of the water in mains being frozen, where it was supposed that the pipes were deeper in the ground than the frost ever penetrates. As for house connections and hydrants, they gave out soon after the commencement of the cold snap. As we explained recently, the house connections were in many cases unduly exposed by the carelessness of the plumbers who did the work. But there were numerous instances in which the water froze in connections that were laid on the level of the main. It did not need an occurrence of this kind to prove that there are a great many plumbers who have no consciences, for we see in the daily papers numerous remarks in regard to their outrageous charges, at all seasons of the year. But the manner in which they ordinarily proceeded to thaw out a frozen pipe seems to cap the climax, in regard to making repairs in the most expensive manner possible. As a general rule, when the water in a house connection was frozen, the plumber would lay a portion of the pipe bare, and light a fire around it, consuming from one to three cords of wood, and keeping several men employed for from twelve to thirty-six hours, or even longer. In this manner he would manage to run up nice little bills of thirty, fifty, one hundred dollars, and more, if we can credit the statement of victims, published in the daily papers. In some extended tours of observation throughout the city, we have seen but two or three boilers in use, furnishing steam to thaw out the pipes. It is such a simple means of clearing a pipe, and the boiler required can be constructed so cheaply, that we were surprised not to find them generally employed. As a result of a good deal of inquiry, however, we infer that the plumber reasons somewhat in this manner: "It will cost me thirty or forty dollars, or perhaps a little more, to make a steamer; and if I use it, I can clear a pipe in two or three hours. But if I keep on in the good old way, and build a wood fire around the pipe, I will incur no expense at starting, and will be a day or two about the job." We shall be greatly mistaken if some enterprising individuals do not draw a useful moral from these facts, or if, by another winter, the charges for this class of plumber's work at least will be properly regulated. While the house connections were becoming frozen, the street hydrants were following suit; and we see by the papers that in some cases they were frozen so hard that fires made great headway before they could be brought into service. We have been edified, in New York, by disputes between two departments, as to whose duty it was to thaw out the hydrants; but we have not seen much stress laid upon the fact that it is somebody's duty to prevent the hydrants from freezing up. In fact, we find a good many people who seem to think it is the correct thing for ice to form in a hydrant in cold weather, so that it cannot be used until the ice is melted. On the contrary, however, if a hydrant is properly constructed and cared for, no ice will ever form in it until the main with which it is connected becomes frozen. We could give a number of reasons in support of this assertion, but a practical proof will no doubt be more satisfactory to our readers. On the occasion of a recent visit to Poughkeepsie, in this State, we were very courteously shown around the water works by Mr. Davis, the superintendent. This gentleman informed us that, though it had been cold enough to form ice in one or two instances in the mains, all the hydrants had been serviceable, with a single exception. This single hydrant, which was frozen up, well illustrates the value of system. The hydrants are all inspected every day to see whether or not they are frozen; and immediately after a fire, the hydrants that have been opened are examined by an employee of the water department, to make sure that they are properly drained and closed. After one fire, the chief engineer of the fire department reported that three hydrants had been opened, while, in fact, four had been used. As a consequence, the fourth hydrant was not examined, and ice formed in it during the night; but it was discovered early the next day and thawed out. Now it seems to us that this demonstrates that hydrants can be kept ready for use even in very cold weather, although, as generally managed, they are very apt to freeze. It may be added that there are some forms of hydrants that should never be employed in a region where pipes are liable to become frozen up.

INCREASE OF POSTAL CHARGES.

The same Congress which rendered itself infamous by the passage of the well known salary grab again looked after its own interests, at the expense of those of the public, during the last hours of the late session, by enacting a law altering the postal rates in order that its own speeches might be enabled to cumber the mails. By a recent amendment to the postal law, the speeches of members and other stuff are to be sent free, while the postage charged to the public is doubled in price. Instead of half a cent an ounce, the scale is now altered to one cent an ounce on every one of the following articles: Books, pamphlets, maps, prints, engravings, transient magazines, periodicals and newspapers, circulars, handbills, posters, occasional publications, prospectuses, book manuscripts, proof sheets, blanks, patterns, samples, and, in fact, all articles sent by mail except letters, and newspapers and periodicals sent by publishers. The new rate imposes an enormous additional expense on those who use the post office as a means of transmission for articles more bulky than simple letters.

That this additional tax upon the people is due, in large measure, to the lobbying influence of the express companies there is very little room for doubt. Cheap postal rates are obviously in opposition to their interests, and it is well known that a strong and constant pressure has been brought to bear on Congress in their behalf during the past session. The express charge for the smallest package sent from New York to San Francisco is 75 cents; the post office carries one weighing a pound for sixteen cents, and before the recent amendment did the same service for eight cents. In some cases, for packages of certain weight forwarded short distances, under the old law the mail rates were much below the express charges; under the new, the former are considerably higher

There is a large number of persons whom the measure will directly affect in a business point of view. Publishers of books, of pamphlets, in fact of all works other than periodicals, many of which are of great value to the community as disseminators of useful information, will find it necessary to reduce the weight of their packages one half, in order to mail them at the same price as formerly. From this follows a diminution of labor and a decreased consumption of paper and material, and thus other classes of the public are in turn affected. Mercantile houses selling by samples sent by mail, shippers of seeds and of manufactured productions readily inclosed in small packages, and like forwarders will, in many instances, find the doubled postal charge by no means an inconsiderable inroad into their profits, and it will necessitate on their part a reduction in the weight of the articles sent. The consequence of the above, so far as the postal revenue is concerned, is that it will remain stationary, and will not experience that gradual increase which has always been attendant upon the cheapest tariffs.

The measure generally affects the reading public. Three cents postage must now be paid on the SCIENTIFIC AMERICAN and other large papers, and eight cents on each magazine that formerly went for four, and so on. Besides, a rather anomalous state of affairs is caused when a person is charged three cents to send this paper across the river from New York to Brooklyn, and but two cents to forward it over the ocean to London.

The country has very little cause for gratitude to Senator Hamlin, of Maine, for pushing through this ill-advised law. Its prompt and early repeal is a measure which the next Congress will doubtless find is demanded by the people.

MODELS BY MAIL.

We recently advised our readers that, by the provisions of the new postal law, they were at liberty to send models and other matters through the mail, in packets weighing not more than four pounds, at the rate of eight cents a pound; and we dilated a little upon the excellence and great public convenience of this arrangement. But scarcely were our types printed before the salary-grabbing Congress made a change in the law, doubling the above rates for the public, while ordering their own speeches to be sent *free*. Looked at in one aspect, this is an outrage on the public; but it cannot be helped until the meeting of the new Congress in December. Meantime the public must endure the payment of the doubled rates, and all who propose to send models should bear it in mind. Sixteen cents a pound must now be paid.

A TRADE MARK REJECTION.

The Commissioner of Patents, on an appeal taken to him in person, has had occasion to set aside a decision of the Trade Mark Examiner, who refused registration to the applicant, because the latter stated in his papers that he had not used, *but intended to use*, the mark. The Examiner rejected the application, requiring that, before he would grant it, the applicant must strike out the word "intended" and insert "commenced," thus making the applicant say in his papers that he *had already commenced to use the mark*. As this was not true, the applicant declined so to state, so the case was rejected and the appeal taken.

The Commissioner of Patents reversed this decision, and at the same time administered to the Examiner a rebuke which, if has any sensibility, he will be likely to remember.

"The language of the statute is made so plain that it would seem impossible for any one to err therein. Yet this plain language the Examiner assumes to criticise as loose, and interprets it exactly contrary to the obvious meaning by an altogether unnecessary inference."

The decision of this Examiner is only one of the many examples of Patent Office errors which are not likely to be eliminated while the present practice is maintained. About one hundred examiners are now employed, chiefly in hunting up objections to the grant of petitions for patents. If they did not make large numbers of incorrect rejections, their occupation would, to a great extent, be gone.

PARTNERSHIPS OF ANTS AND PLANTS.

The curious observations of the "Naturalist in Nicaragua," in connection with the ant-supporting plants and plant-protecting ants of tropical America, have been described in these columns. In certain *acacias* and *cecropias*, it will be remembered, Mr. Belt found the ants serving as volunteer armies for the defence of the trees against invasion by insect or other enemies, resenting with bites and stings the slightest interference with their charge, while the plant in return provided habitations for the ants, and either special secretions and fruits for their sustenance, or juices for the support of their domestic cattle: the relation between the two being so close that neither could thrive without the other.

It appears from the investigations of Mr. Britten, of the Botanical Department of the British Museum, that this remarkable sort of partnership is not so rare as has been supposed. His attention being called to the matter by Mr. Belt's observations, Mr. Britten has gone over the books and material at his command, and collected the scattered notices of ant-tenanted plants, a *resumé* of which he gives in a long article in the *Popular Science Review*, mentioning the following orders and genera as affording known examples, and specifying the parts of the plants which the ants inhabit

Leguminosæ: Acacia, various species: thorns.

Melastomaceæ: Tococa, calophysa, mycrophysa, myrmidone, and *maieta*, various species: petioles and leaf bases.

Rubiaceæ: *Myrmecodia* and *hydrophytum:* tubers. *Remijia*, petioles.

Gentianaceæ: *Tachia Guianensis:* stems.

Boraginaceæ: Cordia nodosa: base of petioles.

Verbenaceæ: Clerodendron: internodes.

Polygonaceæ: Triplaris, various species: trunks and branches

Artocarpaceæ: Cecropia peltata: trunks and branches.

Orchidaceæ: Schomburgkia tibicinis: pseudo bulbs.

One of the most striking instances of this sort is afforded by *myrmecodia tuberosa*, to the very existence of which it is essential that the tuber should be tenanted by ants. It was discovered by Rumpf, in Amboy, something over a hundred years ago; but he was uncertain whether the whole was a vegetable or whether the tuber was an ant's nest from which the plant sprung. It presents the form of a large, irregular tuber, from which spring a few thick, fleshy leaves crowded together at the summit. Dr. Beccari, who has lately collected the plant in Borneo, has watched the development of the tube throughout all its stages. The seed is surrounded by a viscid pulp, resembling that of the mistletoe, and readily attaches itself to the branches of trees on which it falls. It is probable that birds aid also in its distribution. The seed soon germinates under favorable conditions and unfolds its cotyledons; the stem develops slightly, then stops until a particular species of ant burrows a small lateral cavity at its base. The wound determines a great development of cellular tissue, as the sting of the cynips causes galls on the

oak; and as the stem enlarges into a sort of tuber, the ants excavate galleries in all directions and establish therein their colony. The marvelous part of the matter is that, if the stem is not invaded by the ant, it fails to develop and the plant dies. The apparently abnormal tuber appears to be essential to the growth and maturity of the plant; and the ants—a small, red, and very fierce variety—aid in protecting the plant by making it unpleasant for anything which happens to disturb their dwelling.

The genus *myrmecodia* was formerly regarded as exclusively Malayan; but it is now known to be represented in Java and also in Australia. Five specimens of an Australian species are now growing at Kew Garden.

They have a slaty-gray color and greatly resemble wasps' nests. The galleries with which the tubers are intersected are lined by the ants with a thin papery material. Whether colonies of ants were imported with the plants, Mr. Britten does not say. The allied genus *hydrophytum* has a similar structure, and the best known species, *h. formicarium*, is tenanted by ants. There are three or four other species known, natives of Tropical Australia, the Fiji Islands, and the Indian Archipelago.

The next occurrence of the sort was observed by Aublet, and described in 1775, in his account of the plants of French Guiana. Aublet mentions two species of *triplaris* as inhabited by ants which acutely tormented him when he interfered with the trees in which they had taken up their residence. More recently Weddell, describing these trees, the trunk branches and even the smallest twigs of which are hollow and tenanted, says that, if one happens to touch the trunk of a *triplaris* accidentally, especially if it be shaken, the ants rush out by hundreds from the interior through the small canals by which the medullary canal communicates with the exterior; and if escape is not made quickly, the intruder is covered with dangerous guests, the bite of which is exceedingly painful. The Indians of Guiana call the *triplaris* the "ant tree," the tree being occupied by ants in every stage of its development. Weddell has found the tree, and suffered from the attacks of the ants, a clear brown variety, in many parts of Brazil, in Bolivia, and in Peru.

In the work already mentioned, Aublet describes also a shrub of the genus *tachia*, the stems of which, like those of the *cecropia* described by Belt, furnish bed and board for species of ants. The Galpis call it *tachia*, which in their language signifies "ant's nest."

The bases and petioles of the upper leaves of certain South American species of the genus *cordia* are similarly tenanted, so likewise are the leaves of a number of closely allied genera of *melastomaceæ*, all natives of South America. In these it is usually the petiole which has developed a form adapting it as a residence for ants. The following description, which Aublet gives of the mode of growth in the *tococa Guianiensis* will apply with slight modifications to all the other genera: The leaves are attached to the stems by a small hairy petiole, hollowed out into a groove on its upper surface and convex below. The two sides of the petiole swell out so as to form a double heart shaped bladder, corresponding with which are two holes on the under side of the base of the leaf, between the two intermediate nerves. Through these holes the ants have access to the divisions of the heart-shaped bladder. The stems, which are hollow, are entered by different openings. Mr. Belt describes a similar arrangement which he observed in an allied plant in Northern Brazil. A Mr. Trail, who is at present investigating this subject in Central America, writes to Dr. Hooker from Santarem, that at least three species of ants inhabit a melastomaceous plant of that region: he believes it to be *myrmodona formicaria.*

The manner in which the *acacia* known as the bull's horn thorn is tenanted and defended by ants in Nicaragua, as observed by Mr. Belt, was described in the SCIENTIFIC AMERICAN last summer.

In Honduras an orchid affords an equally satisfactory residence for ants. The hollow pseudo bulbs have a small hole at their base through which the ants enter; and so thoroughly do they take possession that Mr. Skinner, who discovered the plant, was almost prevented from collecting specimens by the stings of the swarms which rushed out upon him when he touched the plant. The orchidaceous plant referred to by Mr. Bates, "The Naturalist on the Amazons," in describing the formicarium of the Brazilian *crematogaster limatus*, was probably a relative of the one described by Mr. Skinner.

Now that attention has been called to the matter, it is quite likely that other partnerships of the sort will be discovered. Indeed Mr. Britten mentions several plants, specimens of which give evidence of such occupation. They are all South American species: a rubesaceous plant no referred to *Remijia*; and two species of *hyptis—h. Salzmanni* and *h. calophylla*—which almost invariably present hollow swellings suitable for formicaria

MOLECULAR CHANGES IN METALS.

BY PROFESSOR R. H. THURSTON.

In a series of articles contributed to the SCIENTIFIC AMERICAN during the past year, the writer gave an outline of the various phenomena affecting the strength of metals used in construction, and described some that were peculiar in character and but recently discovered, illustrating these facts by graphic representions of the changes of resistance with change of form, such as were obtained by the automatic action of the autographic testing machine of the Mechanical Laboratory of the Stevens Institute of Technology. There are some phenomena which cannot be conveniently exhibited by strain diagrams; such are the molecular changes which occupy long periods of time. These phenomena, which consist in alterations of chemical constitution and molecular changes of structure, are not less important to the mechanic and the engineer than those already described. Requiring, usually, a considerable period of time for their production, they rarely attract attention, and it is only when the metal is finally inspected, after accidental or intentionally produced fracture, that these effects become observable.

The first change to be referred to is that gradual and imperceptible one which, occupying months and years, and under the ordinary influence of the weather, going on slowly but surely, results finally in important modification of the proportions of the chemical elements present, and in a consequent equally considerable change of the mechanical properties of the metal. The process of oxidation, or corrosion, is such a process, and is the most familiar one. Cast and wrought iron are both subject to it, the latter to, by far, the most serious extent. Cast iron is comparatively little affected by oxidation, even where exposed in wet situations or to alternate moisture and dryness. Wrought iron, under ordinary conditions of exposure, is said to become rusted to the depth of a sixteenth of an inch in a quarter of a century. In exceptionally trying situations, it corrodes far more rapidly. Steam boilers are sometimes rusted through, about the water legs, at the rate of a sixteenth of an inch a year, and instances have been known of even more rapid work that this. Exposure, however, while producing oxidation, has another important effect: It sometimes produces an actual improvement in the character of the metal.

Every mechanic knows that old tools, which have been laid aside or lost for a long time, seem to have acquired exceptional excellence of quality. Razors which have lost their keenness and their temper recover, like mankind, when given time and opportunity to recuperate. A spring regains its tension when allowed to rest. Farmers leave their scythes exposed to the weather, sometimes, from one season to another, and find their quality improved by it. Boiler makers frequently search old boilers carefully, when reopened for repairs after a long period of service, to find any tools that may have been left in them when last repaired; and if any are found, they are almost invariably of unusually fine quality. The writer, when a boy in the shop, frequently, if denied the use of their tools by the workmen, looked about the scrap heaps and under the windows for tools purposely or carelessly dropped by the men; and whenever one was found badly rusted by long exposure, it proved to be the best of steel. One of the most striking illustrations of this improvements of the quality of wrought iron with time has recently come to the knowledge of the writer. The first wrought iron T rails ever made were designed by Robert L. Stevens about the year 1830, and were soon afterward laid down on the Camden and Amboy Railroad. These were Welsh rails, and, when put down, were considered, and actually were, brittle and poor iron. Many years later, these were replaced by new rails, but until quite recently some still remained on sidings. When a lot of unusually good iron was wanted, some of these rails were taken up and re-rolled into bar iron. The long period of exposure had so greatly changed the character of the metal that the effect was unmistakable. These facts are stated by gentlemen upon whom perfect reliance may be placed.

"But," it will be asked at once, "how can such changes occur without apparent cause, however long the time?" There are probably two methods of improvement, each due to an independent molecular action. In the case of the razor and the spring, which regain their tempers when permitted to rest, it seems probable that a molecular rearrangement of particles, disturbed by change of temperature in one case and by alternate flexing and relaxing in the other, goes on, much as the elevation of the elastic limit and the increase of resisting power, discovered by the writer and shown on the strain diagram, takes place under strain and set. The other cases may probably be due to a combination of this physical change with another purely chemical action, which is illustrated best in the manufacture of steel by the cementation process. In this process, iron, imbedded in charcoal and kept at red heat, gradually absorbes carbon and becomes steel. Here the element carbon enters the solid masses of iron, and diffuses itself with greater or less uniformity throughout their volume. There seems to exist a tendency to uniform distribution which is also seen in a thousand other chemical changes. Many chemical processes are accelerated, checked, and even reversed by simple changes of relative proportions of elements, which compel acceleration or reversal as the only means of securing this uniformity of distribution.

When, therefore, wrought iron, containing injurious elements capable of oxidation, is exposed to the weather, the surface may be relieved by the combination of these elements with oxygen, and the surcharged interior, by this tendency to uniform diffusion, is relieved by the flow of a portion to the surface, there to be oxidized and removed. This process of flow goes on until the metal, after lapse of years perhaps, becomes comparatively pure. Meantime the occurrence of jarring and tremor, such as rails are subjected to, may accelerate both this and the previously described change.

The effect of strains frequently applied, during long intervals of time, is quite different, however, where they are so great as to exceed the elastic range of the material. The effect of stresses which strain the metal beyond the elastic limit has already been referred to in the SCIENTIFIC AMERICAN. The case of the porter bar (of which a sketch was given, showing how, after a long period of severe usage, it finally broke suddenly, exhibiting the peculiar fracture characteristic of such a method of rupture) will probably be remembered by many readers. A still more marked case has recently come to the notice of the writer

The great testing machine at the Washington Navy Yard has a capacity of about 300 tuns, and has been in use 35 years. Quite recently, Commander Beardslee, whose valuable work has been alluded to in this paper, subjected it to a stress of 288,000 lbs., but it subsequently broke down under about 100 tuns. The connecting bar which gave away had a diameter of five inches, and should have originally had a strength of about 1,000,000 lbs. Examining it after rupture, the fractured section was found to exhibit strata of varying thickness, each having a characteristic form of break. Some were quite granular in appearance, but the larger proportion were distinctly crystalline. Some of these crystals are large and well defined. The laminæ, or strata, preserve their characteristic peculiarities, whether of granulation or of crystallization, lying parallel to their axis and extending from the point of original fracture to a section about a foot distant, where the bar was broken a second time (and purposely) under a steam hammer. It thus differs from the granular structure which distiguishes the surfaces of a fracture suddenly produced by a single shock, and which is so generally confounded with real crystallization. This remarkable specimen has been contributed by the Navy Department to the cabinets of the Stevens Institute of Technology.

The somewhat similar instance of the dropping-off of the end of an immense shaft at the Morgan Iron Works, some time since, while the opposite end was under the steam hammer, has been described in the SCIENTIFIC AMERICAN.

Were more conclusive evidence required of the occurrence of crystallization of iron, it has recently been given by an interesting incident at the Stevens Institute of Technology. A pupil, while annealing a number of steel hammer heads,

Fig. 1.

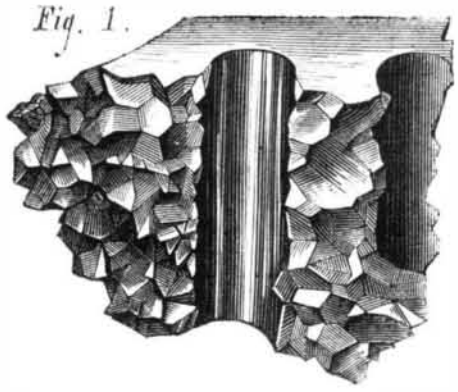

Fig. 2.

left them exposed all night to the high temperature of the air furnace in the brass foundery; when finishing one of them, a careless blow broke it, and the fractured surface was found to possess a distinctly crystalline character. In this example, however, the faces were all pentagonal, and were usually very perfectly formed. These illustrations are conclusive of the question whether iron may crystallize under the action of long continued and severe shocks, or of high temperature. When imperfect crystals are developed, it is easy to mistake them, but the formation of pentagonal dodecahedra, in large numbers and in perfectly accurate forms, may be considered unmistakable evidence of the fact that iron may crystallize in the cubic, or a modified, system. This may apparently take place either by very long-continued jarring of the particles beyond their elastic limits, or under the action of high temperature, by either mechanical or physical tremor. But no evidence is given here that a single suddenly applied force, producing fracture, may cause such a systematic and complete rearrangement of molecules. The granular fracture produced by sudden breaking, and the crystalline structure produced as above during long periods of time, are, apparently, as distinct in nature as they are in their causes. The broken hammer head is so beautiful and perfect an illustration, and such instances are so rare, that it has been drawn and engraved by the accomplished gentlemen attached to the SCIENTIFIC AMERICAN, and appears in this article as the first illustration of the kind which has appeared in the literature of engineering.

STEVENS INSTITUTE OF TECHNOLOGY, HOBOKEN, N. J.

Bacteria and Putrefaction.

Dr. Arnold Hiller, of Berlin, has made a series of elaborate experiments with the view of determining the relations of bacteria to putrefactive changes, and has come to the conclusion that the whole subject needs to be re-examined from the beginning. He has demonstrated that active putrefaction may take place in the absence of bacteria, and that bacteria may be present in abundance without giving rise to putrefaction. In short it seems quite possible that effect may have been mistaken for cause.

THE managers of the International Centennial Exhibition will promote the interests of the enterprise by establishing an agency in New York, and announcing the fact through the newspapers. A number of persons call at the office of this paper every day for information which we are unable to give.

A ONE track prismoidal railway is to be in operation by July 5, 1875, from Sonoma, Cal., to deep water in Sonoma creek, thus making communication by rail and water with San Francisco.