copper and cloth into pieces of about two inches square, dipping each piece of cloth into a saucer containing the dilute sulphuric acid. He is now ready to commence piling, on a small block of wood, a square of zinc, then of copper, then of the moistened cloth, until he has from five to ten pairs or more as he may desire, finishing with a square of copper. Instead of the dilute acid, common salt may be sprinkled on both sides of the cloth after moistening with rain water, and the pile then constructed as before. Also, instead of zinc, strips of sheet iron may be used, although the resultant voltaic pile will not be so strong, in other words, have as much electromotive force.

On a wooden stand, similar to a filter stand with two arms, let the coil of wire hang from the upper arm, and the magnetic needle rest in the middle of the coil on the lower arm. To make the movements of the needle more apparent, remove it from its box, and let it oscillate on a stout sewing needle thrust through a cork and placed, as stated, in the center of the coil.

If now the ends of the coil of wire are so placed that one is under the lowest zinc of the pile, in full contact, while the other end of the coiled wire is pressed flat on the upper or last copper square, the needle in the coil will tend to set itself at right angles to the plane of the coil. By reversing the wires, and placing the end which rested on the copper, now in contact with the lower zinc, etc., then the needle will be reversed also, although still coming to rest at right angles to the plane of the coil of wire, or so-called current of electricity.

One source of interest, connected with this experiment, is the fact that it may aid us in understanding the declination of the needle, which varies as the plane of the electrical current varies. It may also aid in our understanding certain dynamical phenomena, by suggesting that the salt water from the ocean (rendered strong brine by evaporation on reaching heated portions of the earth's crust) may occasionally penetrate deep fissures, and there encounter metals such as native gold, copper, magnetite, etc., besides other more readily oxidizable metals, or those prompt to unite with the chlorine of the salt; thus giving rise to electro-chemical action, and furnishing electromotive force for some seismic phenomena.

Diagram No. 1 is subjoined, to make the above experiment more intelligible.

SECOND EXPERIMENT.

Two bar magnets (costing perhaps 50 cents, and useful for many other interesting experiments) are placed across each other, on a block of wood, as in diagram No. 2, with the S. or unmarked ends of each diverging some 23° respectively to the east and west of the geographical north.

Presenting the small magnetic needle, mentioned in experiment No. 1, while held in the hand successively to the north and south ends of the bar magnets, also to points midway between the two influences, it will be found that, besides the four areas of greatest intensity, near the ends of the magnets, there are curved lines, resembling the agonic, or lines of no variation on our globe, anywhere along which the needle will point to the true north, as indicated in diagram 2. There will also be found a point (resembling the magnetic north pole in Boothia Felix) north of which the magnetic needle will turn its marked end to point due south, while south of that point it will turn its marked end due north. An examination of the phenomena exhibited in this experiment may enable the student to understand the general principles of the declination or variation of the magnetic needle (at many places on our globe) from the geographical north and south; especially when he considers that the same effect may be produced by currents of electricity, if, as in diagram 3, the plane of the main so-called current be successively in A B (solstitial), then in A′ B′ (equatorial), and finally in A″ B″.

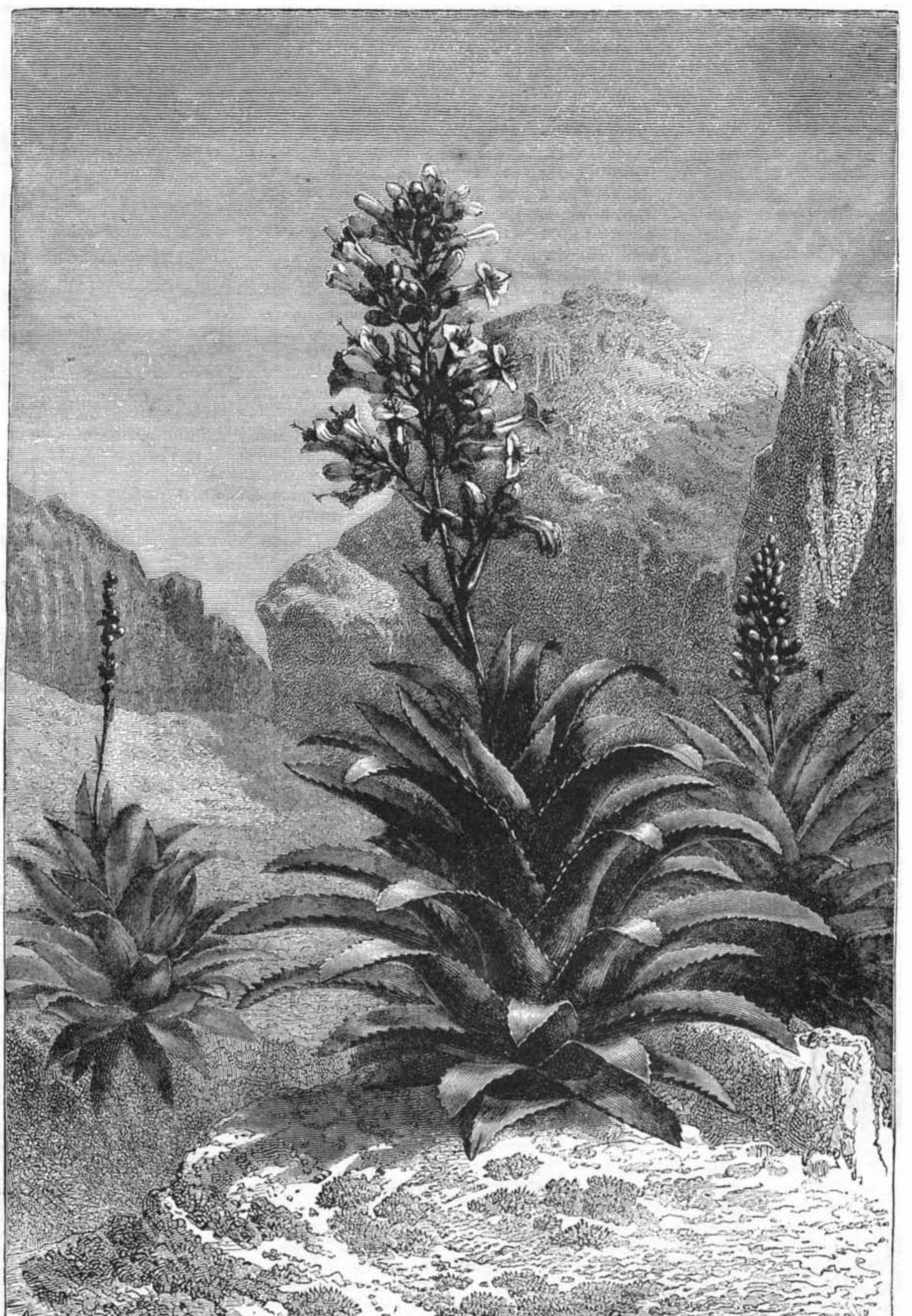
The current A B would necessarily, if strong enough, according to Oersted's discovery, and as shown in experiment 1, produce the same effect, on a small needle, which would be effected by the bar magnet that points in the diagram 2 to the west of the geographical north. The current A′ B′ would produce an effect equivalent to bringing the two bar magnets together; and the current A″ B″ would, in the same manner as if the two bars were made again to diverge, restore the attractive influence (exerted on a small needle) to the region occupied, in diagram 2, by the magnet which points east of north.

RICHARD OWEN.

New Harmony, Ind., December 31, 1884.

A Chance for American Bridge Builders.

It will be seen from an advertisement in another column that the Colonial Government of New South Wales, Australia, is about to build a new and splendid steel railway bridge, for which proposals are now invited. The bridge structure will be 2,900 feet long; the foundations are to be sunk 120 feet below the bed of the river, in water 50 feet deep.



ÆCHMEAS AT HOME.

ÆCHMEAS.

Everywhere there are evidences that a growing interest is being taken in bromeliaceous plants—an interest that should be encouraged, leading, as it inevitably must, to the introduction into English gardens of a large number of beautiful and eminently useful plants of easy cultivation. England alone among European countries where horticulture prevails has hitherto been practically without Bromeliads as ornamental indoor plants.

Next to Billbergias, the Æchmeas are the most useful among genera comprised in the Bromeliad order, although there are several species of Tillandsia and of Vriesia which are of exceptional beauty. Of the genus Æchmea nearly sixty species are described by Mr. Baker in his recent monograph of the genus, of which about a dozen are known in gardens, both in England and in Continental countries. For the following descriptions of these cultivated species I am largely indebted to Mr. Baker's monograph, prepared from living specimens in the Kew collection, and, therefore, more easily understood by horticulturists than any account could be when based on only herbarium specimens. The habit of Æchmeas is generally vasiform (*i. e.*, the leaves clasp tightly by their bases, so as to form a deep cup or vase) with long, leathery, green, spine margined leaves and central flower scapes. In most of the species the flower scape is clothed with large, bright colored bract-leaves, which are often much more ornamental than the flowers themselves. These latter are much smaller than those of Billbergia, and are red-purple, blue, yellow, or nearly white.

Like all the Bromeliads, Æchmeas are natives of distinctly tropical countries, where, either clothing tree trunks in exposed sunny places, or growing upon the ground, they are often met with in abundance.

In the accompanying illustration a rare and interesting species, viz., Æ. paniculata, is shown growing on the ground in a rocky, moist situation. This species is not known to be in cultivation, nor has it been seen wild for many years. It is one of the handsomest of the genus, and should it be again found in the Peruvian Andes, where it was first discovered by Pavon in 1794, its introduction into English gardens would be most desirable.

Æ. BRACTEATA.—A common plant in the West Indies, growing upon trees in sunny positions. Leaves spiny, with broad, sheathing bases, lorate. Height of plant, 2 feet. Flower scape, 1½ feet long, three parts of which are clothed with bright-red sheathing bracts, 3 inches to 4 inches long, the fourth and upper part bearing a branching panicle of numerous small yellow flowers. A large boat-shaped bract subtends and half envelops the lowermost flower branches. A gorgeously colored plant, owing its attractions chiefly to the brilliant red of the large bracts and the contrast between them and the green foliage and the bright yellow flowers. (Syn., Billbergia exudans.)—*Loddiges' Cabinet*, t. 801.

Æ. DISTICHANTHA.—A Brazilian species, with long ensiform foliage, the base of which is broad and sheathing, margins spiny, back of leaves striped with gray. Height of plant, 2½ feet. Flowers in branching panicles about 3 feet long, much crowded, and subtended by bracts; the latter and pea-like flower-buds bright crimson; flowers when open purplish, almost clear blue on first opening. The flowers are succeeded by berries of a bright red tipped with purple, which remain fresh and attractive for several weeks. (Syn., Billbergia polystachya.)—*Botanical Magazine*, t. 5,447.

Æ. VEITCHI.—A species from New Granada, introduced by Messrs. Veitch in 1874, by whom it was distributed under the name of Chevalliera Veitchi. A small plant of erect vasiform habit, with dark green, channeled, spiny-edged foliage, 18 inches high. Flowers on a stout scape, which is about as tall as the foliage and erect, crowned by a compact head or cone of pointed bracts and small flowers, bright scarlet in color.—*Botanical Magazine*, t. 6,329.

Æ. MARIÆ REGINÆ.—One of the handsomest of the genus when in flower. In habit it resembles the last described species, differing in the leaves spreading more and in the flower scape being clothed with bright red reflexing bract leaves, which are 4 inches long by 1 inch in width, margined with spines. The flowers are collected in a cone-like head, the calices being white and urn-shaped, through which the small egg-shaped violet colored corolla protrudes. It is a native of Costa Rica, where it is used at the feast of Corpus Christi for the decoration of the altars in the churches. Its local name is Flor de Santa Maria, from which the scientific name has been taken. Introduced by Messrs. B. S. Williams & Co. The richly colored bracts, which spring from a scape covered with white tomentum and crowned with a cone of white and violet, are strikingly attractive, while in the purple-tinted foliage there is sufficient beauty to give this plant a charm even when not in flower. The flowers are usually borne in the spring, about April.—*Botanical Magazine*, t. 6,441.—*The Garden.*

On Some Causes of Earthquakes.

BY RICHARD A. PROCTOR.

It has been noticed that the Spanish earthquakes have been followed by hurricanes, and many are asking how earthquakes can cause hurricanes. "When an earthquake is succeeded by a hurricane," says the *New York Tribune*, "the inference must be that if the occurrence of the windstorm is more than a coincidence, it must be caused by a profound atmospheric change of pressure, such a change as could only be produced probably by an electrical storm of exceeding violence." This I only quote to show how the question has been raised on the American side of the Atlantic. Of electricity, one may say what Laplace said about the theory of special interference of the Almighty as an explanation of unusual phenomena—"*Ca explique beaucoup de choses.*" It does not seem to have been noticed that the Spanish earthquakes followed a remarkable series of Atlantic storms, and that these earthquakes have continued since the great hurricanes occurred which drove the *Tribune* to the all-explaining electrical theory.

If we consider the matter with a little attention, we shall cease to wonder that great atmospheric disturbances excite subterranean activity. The effects of what seem slight changes of atmospheric pressure must in reality be enormous in modifying the pressures underneath the earth's crust. The barometer often ranges half an inch in height without any great hurricanes following. Taking such a change as this, and supposing that over an area as large as the British Isles, and with the seas between them—say, in round numbers, 100,000 square miles—the barometer stands at 29¼ inches, while on either side, over a similar area, the barometric column has an average height of 28¾ inches; let us consider what difference of pressure is involved, and what are the changes produced if the barometric column is raised half an inch over the British area, and lowered by half an inch over the adjacent areas. The pressure of the air on a square inch, when the barometer stands at 30 inches, is nearly 15 pounds, so that a fall of half an inch (one-sixtieth of thirty) means a reduction of pressure by nearly a quarter of a pound to the square inch. (Or, of course, we may leave the air out of the question, and simply weigh half an inch of mercury in height on a square inch base; this will be one 3,456th part of a cubic foot of mercury, and every one knows that a cubic foot of mercury weighs 848 pounds; the 3,456th part of 848 × 16 ounces is $3\frac{25}{27}$ ounces.) Now in a square yard there are 1,296 square inches, and in a square mile about 3,000,000 square yards. Therefore, at a quarter of a pound to the square inch, the pressure on a square mile amounts to 324 times 3,000,000 pounds, and the pressure on 100,000 square miles to no less than 97,200,000,000,000 pounds. This is 1-54 part too great, because the pressure on a square inch is only 53-54 of 4 ounces. Knock off then a 54th part, getting for the actual difference of pressure due to a half inch rise or fall of the mercurial barometer 95,450,000,000,000 pounds, or in round numbers 42,600,000,000 tons. Can it be supposed to be a slight matter if, as frequently happens, such an enormous pressure as this is thrown upon the area of the British Isles and the seas around and between them, in the course of a few hours, while adjacent areas are relieved of a corresponding weight, and then a few hours later the adjacent areas are oppressed by having many thousands of millions of tons extra weight thrown upon them, while the pressure on the British Isles is diminished in the same tremendous degree? We hear it sometimes described as a remarkable thing that great barometric changes are followed by signs of disturbances in British mines; but when we see that only a moderate and normal change of atmospheric pressure means many thousands of millions of tons added to the pressure on the earth's crust in and around Great Britain, or deducted from that pressure, the wonder seems rather to be that changes so slight are produced by pressures so enormous.

Now, the disturbed areas in the hurricanes of last December were very much larger than those I have just considered, and the differences of atmospheric pressure much more remarkable. The areas of diminished pressure were probably not less than 500,000 square miles, and the surrounding areas of increased pressure fully as large, while the range of the barometer was in some cases fully two inches. This would make the weights added to and taken away from the disturbed areas, sometimes very quickly, no less than a thousand billions of tons. Can we wonder if parts of the earth where the crust is relatively weak and unstable should show the effects of such tremendous changes of pressure as these?

But this is not all. The seas respond to the action of mighty hurricanes, not only by being tossed into waves (which in the open sea are mere risings and fallings of masses of water not themselves carried along), but by being carried in large masses before the winds. Every one knows how a moderate tide is changed into a very high tide by favoring winds, while an expected very high tide becomes a moderate tide when the wind opposes the influx of the water. Along a shore line such as that presented by the Spanish Peninsula toward the west, the water must often be raised two or three feet above its normal level by the action of long continued strong winds from the west. Now, consider one hundred miles of shore line, and the effects of a rise of the sea by only one foot on account of westerly hurricanes, that rise extending only ten miles out to sea. We have, then, a thousand square miles of water one foot deep as the extra pressure upon the crust under that shore line. This gives 27,000 millions of cubic feet of water, each cubic foot weighing 1,000 ounces, or in round numbers about 750 millions of tons of extra water thrown on a shore line only a hundred miles in length. Along 800 miles the additional pressure would be 6,000 millions of tons. This, it will be observed, is very much smaller than the effect due to changes of atmospheric pressure over such an area as the British Isles, but the extra pressure per square mile is nearly twice as great on account of a foot rise in water as on account of a half inch rise of the mercurial barometer. (In the above computation I have taken a cubic foot of water as 1,000 ounces. As a matter of fact, a cubic foot of sea water weighs considerably more, averaging 64½ pounds instead of 62½ pounds—the weight of a cubic foot of fresh water.)

But the rise in the water level due to hurricanes is merely an addition to the rise due to the tides. An extra foot or two due to long continued shoreward winds, added to several feet due to high spring tides, would signify tens of thousands of millions of tons of increased pressure on the Spanish and Portuguese shore line. Moreover, an addition of this enormous weight on one side of a certain definite coast line, while on the other side of this shore line no change at all occurs from this cause, cannot but be a most potent disturbing cause—in a region, too, where the very existence of a shore line indicates irregularity in the structure of the earth's crust beneath.

I take it, then, that we may fairly consider that the external action exerted upon the earth's crust, as the tidal wave sweeps upon a shore line, as winds heap up the seas there, and as atmospheric pressure increases and diminishes—especially during the progress of great storms—must play a most important part in producing subterranean disturbances. At every moment of time millions of millions of tons of matter, in the form of water and air, are being flung hither and thither over the surface of the earth. Can we wonder if, apart from interior causes of disturbance, the crust shows signs of occasional fluctuation?—*Newcastle Weekly Chronicle.*

Proposed Garbage Burning in New York.

To get rid of the ashes and garbage collected in the streets of New York city now requires thirteen dumping stations on the water front and a fleet of scows to carry the refuse to sea, where it is dumped. The quantity so disposed of amounts to about three thousand cubic yards daily, and, in unfavorable conditions of weather, or when those in charge are seeking to shirk their duty, the scows are often dumped so their contents help to fill up the channels of New York harbor. The question of providing a better way of getting rid of this refuse has been a serious one for years, and there is a sum of $50,000 of the regular appropriation which can be expended to this end. It is now proposed, under this provision, to construct furnaces or ovens at or near one of the dumping stations to try and burn up the refuse. The first apparatus will be rather an experimental one, until its economy and the effect of such an incineration factory upon the neighborhood can be determined.

Discovery of the Specific Germ of Diphtheria.

At a recent meeting of the Clinical Society of the New York Post Graduate School, Dr. M. Putnam-Jacobi called attention to the very elaborate and possibly epoch-making investigations, regarding the parasitic nature of diphtheria, which have been made by Loffler.

The result of experiments, conducted with these new bacilli, is summed up by Loffler as follows: They were found in thirteen cases of diphtheria with fibrinous exudation; they lay in the oldest part of the membrane, and penetrated farther toward the tissues than the other bacteria; products of the cultures of them, carried to the twenty-fifth generation, when inoculated under the skin of Guinea pigs and small birds, kill the animals, after the production of a whitish or hæmorrhagic exudation at the point of infection, and extensive subcutaneous œdema. The inner organs remain intact, as do those of diphtheritic patients. Pseudo-membranes were generated by inoculation of the trachea of rabbits, chickens, and pigeons, or of the vagina of Guinea pigs. There are then also evidences of several vascular legions, manifested by hæmorrhagic œdema, by hæmorrhages into lymphatic glands, and effusions into the pleural cavity. The bacilli, he says, have thus the same effects on the animal organism as the diphtheritic virus.

The bacillus which would thus suddenly assume so much of importance to the human race is considered to be identical with the bacillus of diphtheria described by Klebs at last summer's International Medical Congress; and it is a significant fact that two experienced investigators should have thus arrived independently at similar conclusions. The micro-organisms in question are motionless rods, partly straight, partly curved, about the length of the tubercle bacillus but double its breadth, coloring intensely with methyl-blue potassa solution, discoloring again with diluted iodine, except at the two extremities. They are found deep in the tissues, where they are supposed to develop a poison which decays the surrounding tissues, paralyzes the blood vessels, causing congestions, exudations, and finally paralysis of nerve centers and death.—*Medical Record.*

Equilibrium of Forces.

An instrument to illustrate the conditions of equilibrium of three forces acting at a point was lately exhibited at the Physical Society, by Mr. Walter Baily. This instrument consists of a circular disk of soft wood, from the back of which an axle projects. The disk is provided with a graduated circle, and its center marked by the intersection of two fine lines upon a small mirror. Three compound threads, each consisting of two threads connected by a short piece of elastic, are knotted together, the free end of each being fastened to a pin. Two of these pins are stuck into the disk at such a distance from the center that the knotted ends cannot reach the center without stretching each thread, and the remaining pin is then adjusted, so that this condition is fulfilled.

There are now three forces in equilibrium acting at the knot. The angles between their directions are obtained from the readings of the graduated circle where it is crossed by the threads. To determine the magnitude of these forces, the axle of the disk is held horizontally and turned till a thread is vertical, the pin is then removed, a scale pan attached to the end of the thread, and weights added till the knot is brought back to the center. This is repeated with the other threads. It was found possible to show the proportionality of the forces to the lines of the opposite angles with an error not exceeding 1 per cent.

A New Size.

For finishing raw or bleached cotton tissues, particularly for light shirtings, also for starching and dressing warp yarns and skein yarns, instead of the so-called vegetable glue a mixture of potato starch with soda lye is often successfully used; or the soda lye may be replaced by chloride of magnesium. The latter composition is preferable, as the former must be pretty strongly alkaline to preserve its strength. The way of operating is as follows: 50 pounds potato starch are stirred into a sufficient quantity of cold water until all lumps are dissolved, and brought to a boil, when 50 pounds of chloride of magnesium are gradually added under constant stirring, and finally one-half pound hydrochlorie acid. After one hour's boiling, clear lime water is stirred in until the mass is no longer acid. After another hour of boiling, an artificial glue is obtained. This size, which must be perfectly neutral before using it, is very cheap and serviceable in finishing silks and woolens. The goods assume a fine luster, and even in washing the finish is not easily destroyed. Wheat starch, corn starch, etc., may also be used; potato starch, however, has the greatest tendency to form an insoluble combination with chloride of magnesium and lime. This mass is used in cases where gum, dextrin, or paste used to be employed; it is no substitute for animal glue, however.—*Woch.*