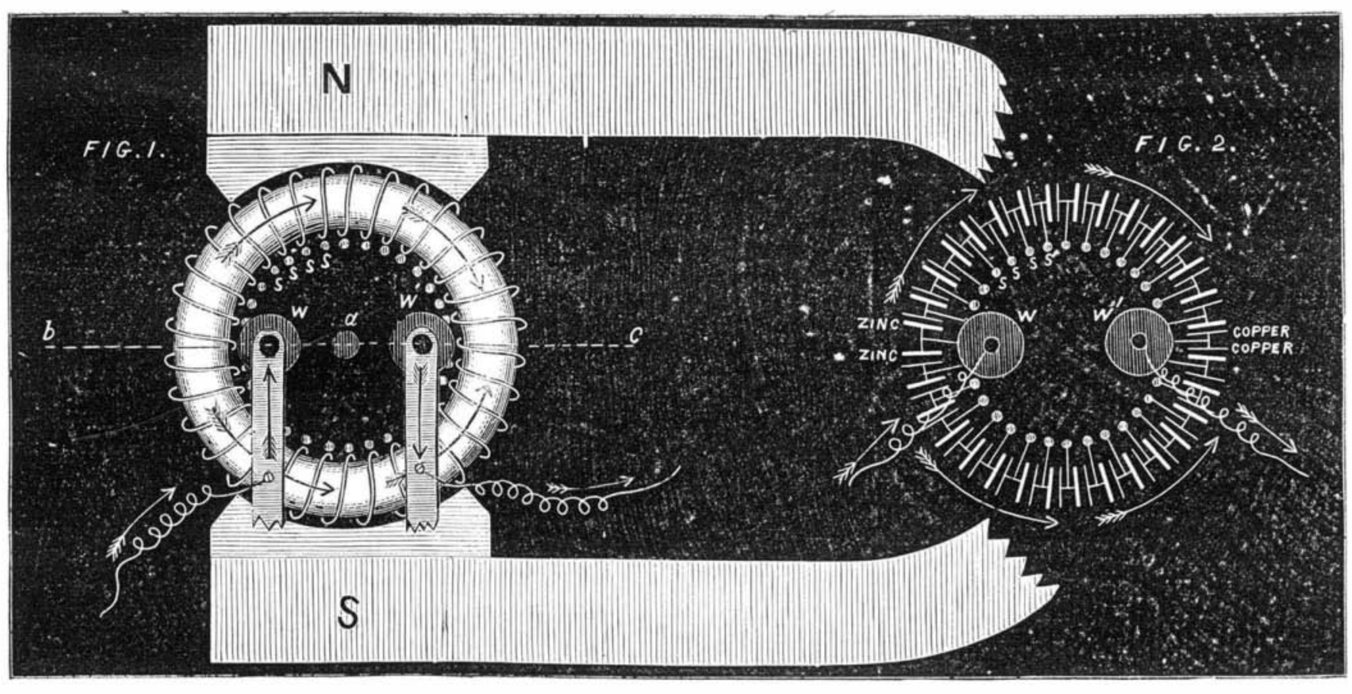
NEW MAGNETO-ELECTRIC MACHINE.

In all the magneto-electric machines hitherto constructed, only an approximation to a continuous current has been arrived at, and that either by making each machine a compound one, having several armatures arranged so that, when the current ceased in one, it was taken up by the next, and so on, or, in other machines, by driving the armature or armatures at a very high velocity, so that the interval between the cessation of one current and the commencement of the next became inappreciable.

In M. Gramme's machine, says the *Mechanics' Magazine*, the current, whether the machine be turned slowly or quickly, is continuous. Fig. 1 is a theoretical representation of this machine. It consists of a horseshoe magnet, N S, between the poles of which turns an iron ring with an insulated wire wound round it in one continuous length. The inner beads of the turns of this wire are connected with small studs, *s s s s*, insulated from one another. The edge of the faces of two wheels, *w w'*, press against these studs, as shown, so that as the iron ring with the wire wound around it rotates, three or more of these studs are always in contact with them. In the actual machines, each of the turns, as represented in the engraving, is really a separate coil of several turns of wire, the junctions between the ends of one coil and the next being connected with the studs; and the iron ring is not necessarily one of round iron, but may be, or rather is, a short and very thick soft iron tube, and the permanent magnet a proportionally broad compound one. The action of the machine may be explained as follows: Let us regard the turn of wire just above the line, *b a c*, on the left hand side of the ring. The portion of the iron ring above this turn, that is to say, the portion nearest the pole, N, has the same polarity as that pole, while the portion of the ring below the turn has southern polarity. Now as the ring rotates about *a*, the portion of the ring above the line, *b a c*, becomes more strongly north as it approaches N, and the part below less south as it recedes from S; and, finally, when it arrives at N, the polarity on both sides is the same, which is as much as to say there is no magnetism in it. This change causes a current of electricity to be induced in the wire. As the turn now moves on towards S, the iron in front becomes a south pole, and that behind a north pole, until it arrives at the line, *b a c*, when the difference of polarity is greatest. This change sends another current through the wire, which, as the turn has become turned over in position, will be in the same direction as the former one, or rather will be a continuation of the first current, so that the turn of wire, in changing from *b* to *c*, has a continuous current induced in it, as have in like manner all the turns before and after it. As now the turn moves further still, the magnetism becomes less and less, as at first, and finally, when at S, disappears, and on going still further becomes reversed as before; this causes a current to circulate through it in a reverse direction to the former one, and so also for all the turns before and after it; these currents together pass out through the studs, in contact with the wheel, *w*, and return when the circuit between the two wheels is completed (as they must be of course before any current can flow) through the wheel, *w'*, and thus a continuous current is kept up as long as the wheel is kept rotating. The circuits of the machine are precisely similar to two sets of cells joined up for quantity, that is to say, the last zinc plate of one set is joined to the last zinc of the other set, and also the last coppers are joined, as shown in Fig. 2, each cell representing one turn, or in the actual machine one separate coil.

It will be seen that as each wheel always presses against three or more studs, the coils between these studs are short circuited, and do not add their power to the others. The resistance of the wire in the machine will be the resistance of the length of wire between the stud pressing against the higher part of the wheel, *w*, and the stud pressing against the higher part of the wheel, *w'*, taken parallel with the length of wire between the studs pressing against the lower part of the wheels, which is equivalent to rather less than a quarter of the resistance of all the wire taken in one length. The resistance is not exactly a quarter, because the coils between the studs pressing on the wheels are in short circuit, and do not add their resistance to the other wire. By constructing the coils of thick wire, a current of great quantity can be obtained, or with a larger length of thin wire, one of great intensity. The electro-motive force of the current is directly proportional to the rate of rotation of the coils—that is, when the rotation is not extremely rapid, for the demagnetization of the iron requires a certain time. The machine, from its great simplicity, is likely to have an extended use for such purposes as electrotyping, the electric light, etc.



MAGNETO-ELECTRIC MACHINE.

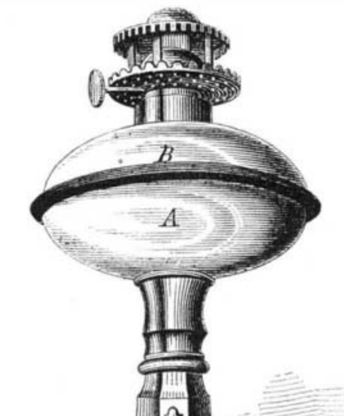
Lac Anilines for Staining Paper, Leather, etc.

Springmuhl states that paper has hitherto been stained in two ways: either the material, previous to manufacture, was dyed with a substantive color, or an adjective color was applied to the finished paper. In the former case, a product was obtained colored through and through; in the latter, the color is only on one side. With a compound of resinous matter and aniline colors dissolved in alcohol, the paper can be rapidly colored at once, on both sides, in the most splendid manner and in an infinite variety of shades. The best resin for the purpose is shellac, to which a little sandarach or turpentine may be added. The resinous aniline solution interpenetrates the whole mass of the paper, giving it a completely even color, and a considerable luster. The two alcoholic solutions of color and of resin may, if needful, be kept separate till required for use.

Every kind of paper, sized as well as unsized, can be prepared in the same manner. The process is very simple: the sheets of paper are drawn through the solution placed in a shallow vessel, and afterwards hung up to dry. By wetting one side of the paper, the same result may be produced, if the texture is not too thick. If the paper is thoroughly interpenetrated with color, it becomes, when dry, so compact and dense that one side can be subsequently treated with a different color. By adding a small quantity of an essence, the paper may at the same time be perfumed. Leather, etc., may be treated in the same manner.

SAFETY KEROSENE LAMP.

Many of the accidents resulting from the use of kerosene arise from the breaking of the glass reservoir when the lamp is overturned by any cause. To obviate this is the intention of the invention we illustrate, and the object appears to be attained by means at once simple and inexpensive.



At A is shown the glass reservoir of the lamp, and at B a ring of india rubber which surrounds its largest circumference. A groove is formed in the glass, into which the rubber ring falls far enough to be kept securely in place, while, at the same time, it projects a sufficient distance from the reservoir to form a protective cushion on every side. Upon the lamp being overturned, the india rubber cushion receives the force of the concussion and preserves the glass from injury. We have upset the lamp from which our cut is made a great many times, to test its strength, without effecting any damage whatever.

Patented through the Scientific American Patent Agency, April 16, 1872. Further information can be obtained of the inventor, Mr. Adolph Otto, whose present address is 76 Ann street, New York city.

PENCIL LEADS.

Graphite, clay, and water are the ingredients of the leads used in the ordinary forms of pencil cases sold by jewelers and stationers. The graphite, or blacklead, as it is commonly termed, that is employed for the purpose is of the finest quality. After being ground to a powder, it is mixed with a peculiar dark blue clay, which is imported from Bavaria, and the whole is kneaded with water until it assumes the consistence of putty.

The apparatus used in the manufacture consists of an iron cylindrical vessel, which is usually of about seven inches in diameter, and constructed of sufficient strength to withstand heavy pressure. In the center of the bottom of this vessel, a small round hole is pierced, and inside the cylinder is a closely fitting movable steel plate which also has an aperture in its center, so that, when it is placed on the bottom of the vessel, the two openings coincide. The hole in the plate, however, is the smaller, being of a diameter equal to that of the leads to be made—so that larger or smaller apertures and, consequently, different plates are required for the various sizes of leads.

Into the above mentioned vessel, after the plate on its bottom is adjusted, the mixture is packed, which, on being forced down by a heavy pressure, is driven out through the hole in long flexible threads. These are received on sheets of metal, and each sheet, as soon as filled, is placed in an oven. The length of time occupied in the baking depends upon whether the leads are to be hard or soft; if the former, they are kept in the oven for some time, if the latter, a short period suffices. This process completed, the threads are broken up into short pieces and arranged according to their sizes. There are nine of these sizes in the trade, numbered from 1 to 9 according to the length of the pieces.

The finished leads are sent to the market packed in little boxes. The latter are either turned from wood or else pressed by dies from thin sheets of tin or brass. Large numbers of them are manufactured at Waterbury, Conn.

Leads at wholesale sell at three dollars per gross. The trade, which is supplied mostly from manufactories in Philadelphia, is, we should judge, of rather limited proportions, as one of the largest dealers in this city informs us that his sales rarely exceed three thousand gross per annum.

SCARLET DYEING ON WOOL AND SILK.—Jegel proposes the following method of dyeing wool and silk scarlet by the simultaneous action of magenta and dinitronaphthol or naphthaline yellow. The less magenta is employed, the better. The method is to heat a dilute aqueous solution of naphthaline yellow to near boiling, add so much magenta as amounts to two per cent of the naphthaline yellow, and then dye. The dye liquor must not be mixed when cold. If this is done, all the magenta is thrown down in an amorphous flocculent state. If this has taken place, the subsequent application of a boiling temperature does not remedy the mischief, since a part only of the magenta thus precipitated is redissolved, the rest melting together into a greenish golden mass. In this state, the liquid is quite unfit for dyeing, and even if filtered gives no good shades.

PREPARATION OF PURE INDIGOTINE BY MEANS OF CARBOLIC ACID.—According to Mehu, carbolic acid, with the aid of heat, has the power of dissolving indigo blue readily. On cooling, the greater portion is deposited in a crystaline state. The cold solution has an intense purple blue color. In order to prevent the carbolic acid from congealing as it cools, a little alcohol may be added, which causes the greater part of the color to be deposited. Instead of alcohol, camphor may be used to the extent of one-fifteenth, or benzine. By using 500 grammes of carbolic acid, we can obtain two grammes of pure indigo blue (indigotin) in crystals which, under the microscope, appear remarkably regular. Mehu employs indigo which has been previously washed, first with water, then with very dilute hydrochloric acid, and then repeatedly extracted with boiling alcohol.

COATING ZINC WITH IRON.—The objects should first be plunged into a hot solution of 160 gms. ferrous sulphate and 90 gms. sal ammoniac in 2,500 c.c. of boiling water. After two minutes' exposure, they should be removed and brushed off in water. This has for its object simply the cleansing of the surface. They are then again placed in the bath and heated, without brushing or washing, until the sal ammoniac fumes are gone, then washed, and this operation repeated three or four times, when a coating of iron will be formed on the zinc, which takes a fine polish under the brush.—*M. Puscher.*

Miners' Unions in Prussia.

The oldest associations amongst working men for mutual aid, of which modern trades' unions are the youngest off-spring, are unquestionably the "Knappschaften," or miners' unions of Germany. They date back more than 600 years and were established wherever German miners migrated; they had written rules and regulations, and generally received corporate rights from the respective sovereigns who wished to encourage mining enterprise within their own dominions, particularly for the sake of winning precious metals. The German miners' unions exist over all Austria, Russia, Norway, and Sweden, where the art of mining was introduced from Germany; and the technical terms, still in use by the profession in these countries, bear witness to their German origin, as well as the general mining laws which regulate the acquisition of mining property from the State and the obligations of mining proprietors towards the sovereign, who holds all mineral treasures under regal rights. In no other country but Prussia, miners' unions or "Knappschaften" have been developed with so much care by legislation for the general benefit of the working miners; and though they are still capable of improvement, they can fairly be pointed out as models which are worthy of imitation for the benefit of the other working classes. The report on the miners' unions in Prussia during the year 1870 has lately been published, and we find in it data which may prove of value to the mining interests of this country, where the improvement of the social condition of a large population of miners is just now being eagerly discussed.

The war of 1870 has not failed deeply to affect the condition of the "Knappschaften," as over 30,000 members were forced by it to leave their peaceful calling and to enter the ranks of the army. The direct object of the miners' associations is to render immediate assistance to its members when they are in need of it, so that, if injured by an accident or if taken sick, they receive assistance during the duration of their illness, besides free medical treatment and medicine. If their case should make it desirable, they are received without cost at one of the unions' infirmaries; and in the event of death, the union furnishes the funeral expenses. If, through any accident or through age, they become too infirm to gain any wages by their work, they receive for life a pension out of the common fund; and according to the degree of their infirmity, they are classed as pensioners, or half pensioners, and obtain help accordingly. If a member leaves a widow and children behind him, the former receives a monthly pension until she dies or marries again, while the children are assisted until they are 14 years old, besides free school to the same age. There are two classes of union members, permanent and temporary, the latter only acquiring personal rights, while the former, after 5 years membership, have their rights extended to all the members of their family; but both classes forfeit their rights when they leave their union without permission, or cease to pay their contribution, which, as a rule, is 3½ per cent of wages earned. The property of the union is thus principally derived from contributions of the members, but also to no small extent from voluntary donations, as well as from contributions of 1 per cent on their incomes, which the mine owners are legally obliged to pay. This fund is under the management of a committee of trustees, "Knappschafts Aelteste," who are freely elected by the members and placed under the control of the Government mining engineer of the district, who is made responsible, to prevent defalcations and to see that members always obtain justice.

On the 1st of January, 1870, the miners' unions comprised 202,562 members, of whom 102,174 were permanent and 100,388 temporary. The number of persons supported by the unions during the year was 45,057, namely, 9,267 pensioners, 277 half pensioners, 13,883 widows, and 21,630 orphans, and school money was paid besides for 45,402 children. The total income of the union was $1,600,000. During the year, medical assistance was rendered to 117,025 persons, sick wages were paid for 1,436,826 days, and 9,486 members received, in all difficult cases, free medical treatment at the hospital. Most of these cases were the results of accidents.—*Engineering.*

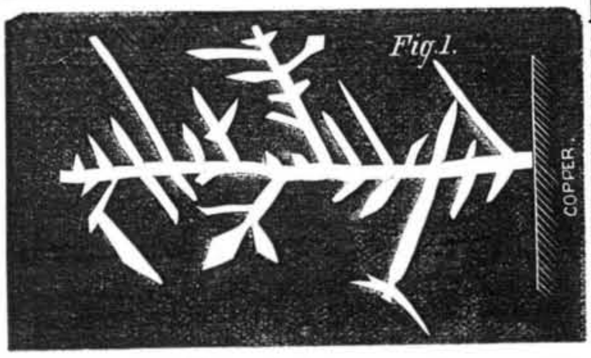
FAST RIDING.—At Dexter Park, Chicago, recently, Charles Rettiker, "the California Boy," undertook the feat of riding on horseback 200 miles in twelve consecutive hours, being at an average speed of sixteen and two thirds miles per hour. The track used was the circular one, seven eighths of a mile in length. Fresh horses were used for each round. On the the twenty-fifth round, the horse bolted the track and leaped the rail, falling upon its rider, who, however, not being much hurt, remounted and finished the round. On the 198th round, the race came to a sudden termination, as the horse again jumped the fence and threw his rider with such force that he was obliged to be taken from the park in a carriage, and he now lies in a very low state, although the physician has some hopes of his recovery. He had made 172⅞ miles in nine hours and twenty minutes, and but for the accident would undoubtedly have accomplished the feat.

GALVANIC ACTION ON IRON SHIPS.—It is an alarming fact in practice says the *Engineer*, and one that, being so perfectly in accordance with theory, ought to awaken no surprise, that should even a minute piece of copper come into contact and so remain, with the inside bottom of an iron ship then wetted with bilge water, as under the circumstances of the case, it, necessarily must be, active galvanic energy is established between the two metals, and iron being the sacrificial metal of the couple, the bottom will, sooner or later—and sooner rather than later—be eaten through in a hole somewhat larger than the superimposed copper.

CRYSTALLIZATION OF SILVER, GOLD, AND OTHER METALS.

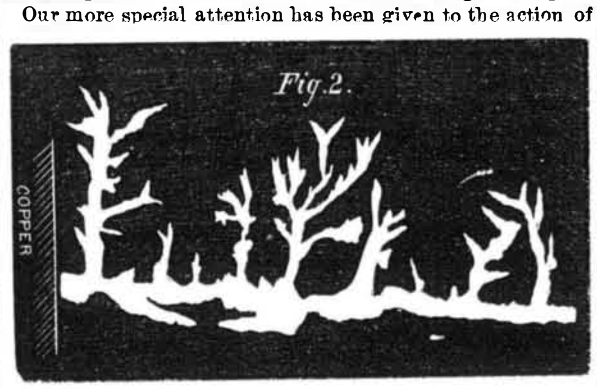
BY DR. JOHN-HALL GLADSTONE, F.R.S., F.C.S.

There are few chemical experiments so well known as the growth of the lead tree, a specimen of which is on the table, together with a silver tree that is said to have been made by the late Professor Faraday. These carry our minds back to the time of the alchemists, who called the first, *arbor Saturni*, and the second, *arbor Dianæ*; and they may be looked upon as the types of a large number of phenomena, in which

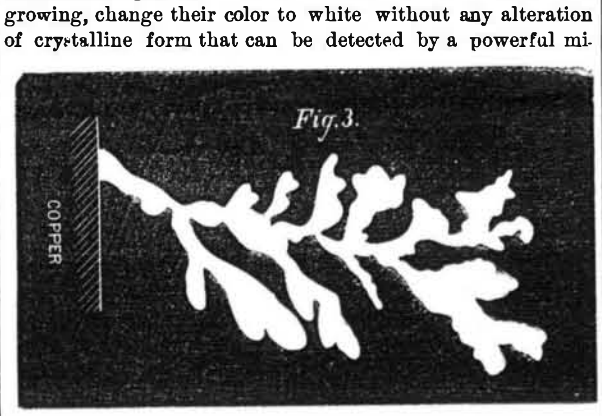


the salt in one metal in solution is decomposed by some other metal. My assistant, Mr. Tribe, and myself have been lately examining these replacements, the metallic crystals which are thus produced, and the forces that act through the liquid.

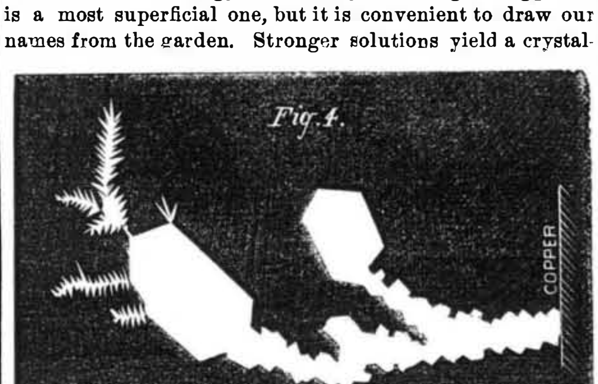
Our more special attention has been given to the action of



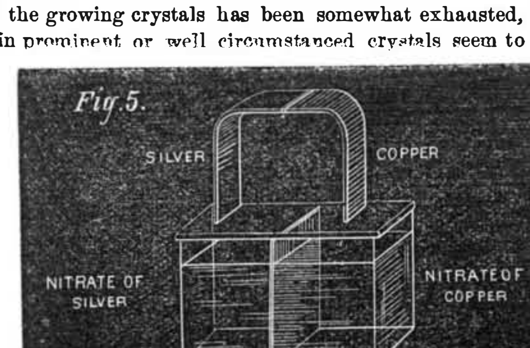
copper and nitrate of silver. The crystals of silver thus produced differ both in color and form, according to the strength of the solution. If it be very weak—say one per cent—the copper is fringed with black bushes of the metal, which, in growing, change their color to white without any alteration of crystalline form that can be detected by a powerful mi-



croscope. A stronger solution gives white crystals from the commencement, which frequently assume the appearance of fern leaves; the analogy between crystals and growing plants is a most superficial one, but it is convenient to draw our names from the garden. Stronger solutions yield a crystal-



line growth rather resembling furze bush, while those of 15 per cent or upwards give a steady advance of brilliantly white moss. In all these cases, however, when the solution in front of the growing crystals has been somewhat exhausted, certain prominent or well circumstanced crystals seem to mo-



nopolize the power, and to push forward through the remaining portions of the liquid. This gives rise to beautiful branches, which assume a variety of graceful forms, but, as a general rule, the weak solutions give feathery and pointed crystals, as in Fig. 1: the moderately strong solutions tend towards jagged forms, as in Fig. 2; while the strongest grow branches that terminate, not in sharp points, but in rounded leaflets, as in Fig. 3. Besides this, there occur all kinds of crystalline combinations, as for instance, the spray sketched in Fig 4. It is very beautiful to watch the growth of these silver crystals round a piece of copper under the microscope; a blue glass underneath adds to the effect, but they are best seen when they reflect a strong light thrown upon them. If, instead of putting a piece of copper into a drop of nitrate of silver, a piece of zinc be placed in one of terchloride of gold, there is at once an outgrowth of black gold, which speedily changes to an advancing mass of yellow, or perhaps of purple metal; and it is very apt to form beautiful fringes, or to shoot its yellow branches rapidly round the margin of the drop. Acetate of thallium yields a forest of thorny crystals; and chloride of tin causes a luxuriant growth of large flat leaflets, or of symmetrical structures resembling fern leaves, except that the smaller fronds are arranged at right angles to one another. The new metal indium gives thick white crystals upon zinc; while bismuth and antimony form black fringes resembling the first action of gold.

The forms assumed by native metals resemble those produced by this process of substitution. In some cases, indeed, it seems almost certain that the deposition of these minerals was effected in the same way, as for instance, the silver which occurs sometimes in tufts, sometimes in large crystals, on the native copper of the Lake Superior district. Gold is frequently found in cubes more or less rolled, but the leaf gold from Transylvania bears a striking likeness to the crystals that form in our laboratory experiments. Silver is often found native as twisted hairs or wires of metal—a form that never occurs in the decomposition of its nitrate by copper, but which can be artificially produced in another way.

There has been noticed a singular tendency in old silver ornaments and coins to become crystalline and friable. Here is an ancient fibula from the Island of Cyprus, supposed to be at least 1,500 years old, which, through the greater portion of its substance, presents a fracture something like that of cast iron, and its specific gravity has been reduced in round numbers from 10 to 9. It contains a little copper. This property of certain metals, or their alloys, to change in condition and in volume, is worthy the attention of those whose duty it is to make our standards. Experiments should be instituted for the purpose of learning what metals or combinations of metals are least subject to this secular change.

These metallic crystals are Nature's first attempt at building. The material is the simplest possible—in fact, what chemists look upon as elementary. But how is the building carried on? What are the tools employed? Where are the bearers of burdens that bring the prepared pieces and lay them together according to the plan of the Great Architect? We must try to imagine what is taking place in the transparent solution. The silver, of course, existed at first in combination with the nitric element, and for every particle of silver deposited on the growing tree, an equivalent particle of copper is dissolved from the surface of the plate. The nitric element never ceases to be in combination with a metal, but is transferred from the one metal to the other. On the polarization theory, the positive and negative elements of the salt constantly change places and enter into fresh combinations, one consequence of which would be a gradual passage of the nitric element from the growing silver to the copper. This actually takes place, and there is a diminution of the salt at the ends of the silver branches, giving rise to an upward current, and a condensation of nitrate of copper against the copper plate, which gives rise to a strong downward current. These two currents are seen in every reaction of this nature. In the case of silver and copper, however, it has been proved that the crowding of the salt towards the copper plate is more rapid than would follow from the polarization theory. The instrument employed for determining this point was a divided cell in which two plates, one of silver and the other of copper, connected together by a wire, are immersed each in a solution of its own nitrate, contained in each division of the cell, and separated from one another merely by parchment paper. The crystals of silver deposited on the silver plate in this experiment are very brilliant.

There are other indications of the liquid being put into a special condition by the presence of the two metals which touch one another. Thus zinc alone is incapable of decomposing pure water, but if copper or platinum be deposited on the zinc in such a manner that the water can have free access to the junction of the two metals, a decomposition is effected; oxide of zinc is formed, and hydrogen gas is evolved. At the ordinary temperature, the bubbles of gas rise slowly through the liquid, but if the whole be placed in a flask and heated, pure hydrogen is given off in large quantity. We have also found that iron or lead similarly brought into intimate union with a more electro-negative metal, and well washed, will decompose pure water.

As might be expected, the action of magnesium on water may be greatly enhanced by this method; and a pretty and instructive experiment may be made by placing a coil of magnesium in pure water at the ordinary temperature, when there will be scarcely any effect visible, and then adding a solution of sulphate of copper. The magnesium is instantly covered with a growth of the other metal, and at the same time the liquid seems to boil with the rapid evolution of hydrogen bubbles from the decomposed water.

When, however, the force of the two metals in contact has to traverse a layer of water, the resistance offered by the fluid prevents its decomposition. This must also be an important element in the decomposition of a metallic salt dissolved in water, and, in fact, we have found that the addition of some neutral salt, such as nitrate of potassium, increases the ac-