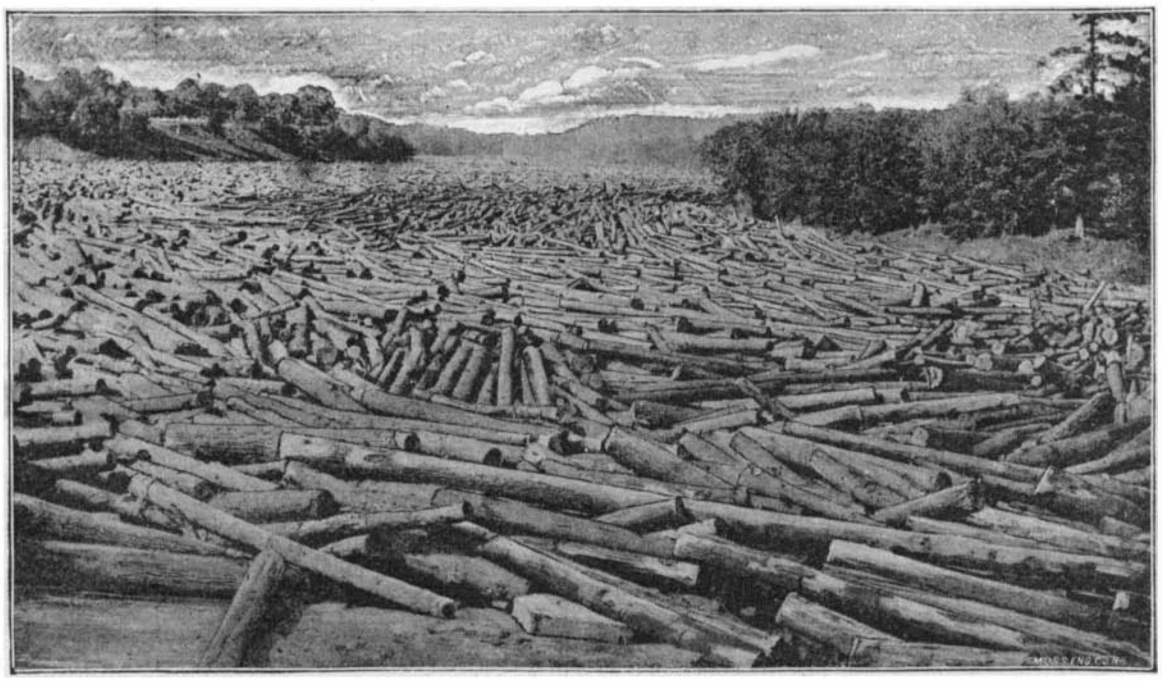
frame that holds the statue upon its pedestal, as shown by the engraving upon opposite page. By this means, the rigidity of the whole work is assured, and any wind pressure—the force most to be provided for—upon the pliable, paper-like shell is transmitted to the four massive iron corner posts of the frame, which are firmly anchored to the masonry.

All the framework in the interior of the statue was made in France; and while there is regularity in the main frame, there is nothing apparent in the connecting bracing but a seemingly confused collection of bars of all shapes and lengths, and extending in every conceivable direction. This is caused by the constant change in the direction assumed by the copper, and the endeavor not to have too large a surface unsupported.

No part of the ironwork is in direct contact with the copper, a thorough insulation being obtained by shellacking the adjoining surfaces and interposing a strip of asbestos. This is necessary to obviate the deleterious chemical action that would occur if the iron were in direct contact with the copper.

The method pursued in the erection of the statue may be briefly described. The framing has been finished with the exception of two small parts—that supporting the right hand and that of the head. The shell of the statue has been carried up only a little further than shown in the engravings.

The various pieces were temporarily stored in a shed between the base of the pedestal and the dock at which visitors are landed by the little tug plying between the Battery and the island. The piece wanted is carried to the foot of the pedestal, the face of which is protected from injury by a covering of wood, and is, if large, lashed to a wooden frame to which is attached the end of a rope passing over a derrick on top of the frame, and thence to a hoisting engine on the ground. The piece is then raised to a platform built around the top of the pedestal, and is carried to the place where its marks indicate that it belongs. When necessary, a rope and tackle are brought into play to raise the piece into position, and to hold it until enough rivets or small temporary bolts have been inserted to secure it. All the rivets are then driven, and the braces are bolted to the frame and stiffening bars. The shell is thus carried up, piece by piece, in horizontal courses. The difficulty of the work increases as the top is approached, mainly because of the increased height above ground, the top of the pedestal, where the statue begins, being 150 feet, and the torch 305 feet above water level.



THE GREAT LOG JAM, ST. CROIX RIVER.

There are three kinds of joints in the copper. Where it is particularly desirable that the joint should be concealed, the meeting edges are brought flush together, and are held by a double line of rivets through a strip covering the inside of the joint. In other cases one edge overlaps the other, a single line of rivets uniting them, and the outer edge is either hammered down to make a flush joint or is not touched further, the selection of the style of seam being governed by its location. The outer heads of the rivets, which are of copper, are countersunk.

The two systems of heavy girders, whose ends are embedded in the masonry in the interior of the pedestal, one at the top and the other sixty feet below, together with the four sets of eyebars that unite the two systems, have been placed in position, as shown in one of the accompanying views. These girders extend across the well at right angles to each other, and, being connected at the top with the main frame, serve to anchor the statue to the pedestal.

Lightning has several times struck the ironwork, but, owing to the means that were early taken to lead the current away, not the slightest damage has been done. Extending down each inside wall of the pedestal is a copper rod five-eighths of an inch in diameter. The lower ends of these four rods are joined to plates that were buried in wet earth beneath the bottom of the foundation before building was commenced. The upper ends are united to the frame, but will, upon the completion of the statue, be joined to four diametrically opposite points of the shell.

Up to the present time, no portion of the foundation has settled; and the solid concrete foundation proper, which is easily the largest single block of artificial stone in the world, being ninety feet square at the base, sixty-five feet square at the top, and fifty-two feet ten inches in height, with a central well-hole ten feet square, is without crack or flaw of any description. The inside of the pedestal walls are also of concrete, the face being granite, and they display the same perfection in both material and workmanship.

It is extremely doubtful if the statue can be finished by the 3d of next month, the date set for what we may term the unveiling. There is much to be done, and the rate of progress is slow, as it is impossible to employ a great number of men.

In the SCIENTIFIC AMERICAN of June 13, 1885, we illustrated and described very thoroughly the foundation, pedestal, and frame.

THE GREAT LOG JAM IN THE ST. CROIX RIVER.

BY H. C. HOVEY.

In order to comprehend the full significance of the great log jam which it is the main object of this article to describe, we must first consider the nature of the surrounding region and the stream that flows through it. The St. Croix was, in geological times, a mighty river, through whose channel the overflow of Lake Superior, and indeed the whole drainage of the interior of North America, was carried down to the Mississippi, and thence to the ocean. At present, however, it is a comparatively small but highly picturesque stream, navigable from its mouth, which is fifty miles below Fort Snelling, up to Taylor's Falls. Just below these falls are what are known as the Dalles of the St. Croix, where the channel, instead of being cut, as elsewhere, through a light-colored and soft sandstone, is suddenly confined between precipitous walls of basaltic rock, one or two hundred feet high, while the river itself has a depth of from forty to seventy feet, and yet flows with much velocity. These mural precipices are carved into caves, fissures, and curious potholes, testifying to the aqueous energy of the ancient stream by which they were made. The largest pothole observed by me was estimated to be as much as thirty feet in diameter, while many others are from five to ten feet across and from ten to twenty feet deep. There seem at first to be two distinct dikes of trap, the one at Taylor's Falls and the other at the falls of St. Croix, about a mile above the former. But more careful examination leads to the conclusion that they are portions of one dike, the intervening valley being filled in with drift. The tall cliffs are everywhere exceedingly broken and wild, with many detached fragments, and standing basaltic columns, highly angular, and even prismatic in shape. The rock is remarkably amygdaloidal, and contains copper, though hardly in paying quantities. It is undoubtedly a continuation of the famous Keweenawan formation, so extensively developed about Lake Superior.

The first steamboat that ever ascended the St. Croix reached the falls in July, 1838, and brought the news that the treaty made the preceding year between Governor Dodge and the Ojibways had been duly ratified, by which were ceded to the United States the extensive pine forests of the St. Croix and its tributaries. A claim was made at once around the falls by Messrs. Baker, Steele, and Taylor. The steamboat mentioned brought men and machinery for erecting here the first sawmill ever built in Minnesota. And then the crash of the woodman's ax and the splash of the mill wheel were first heard in this region, that has since become so famous for its lumber and its mills of various kinds.

From that time to this the forests along the St. Croix have been frequented by lumbermen, whose custom it has been to fell the trees in winter, cut the logs into suitable lengths for the mill, and then depend on the spring floods to carry them down to the mills below. From the falls upstream extend such interminable rapids as almost to justify the voyageur Du Luth's statement to La Salle, that, in descending it, he had "passed forty leagues of rapids." This description also applies to some extent to its tributaries, which are, in order of ascent, the Snake, the Kettle, the Clam, the Yellow, and the Nemakagou rivers.

In each of these tributaries lay last spring what is termed a heavy drive of logs; the entire aggregate being known to be about 300,000,000 feet. When the time came for sending them down the St. Croix, there first came out from the Kettle River about 75,000,000 feet of logs, which passed the rapids and the falls safely. But nearly all the remaining drives came out at once, leaving only about 14,000,000 behind. Imagine 200,000,000 feet of logs swimming together down that crooked, tumultuous river, jostling each other, playing at leap frog, diving beneath the flood, and vaulting into the air. The van at length leaped the upper and lower falls safely, but when they entered the deep and narrow canon known as the Dalles, they were piled in a heap, and at the bend of the river, about a furlong below Taylor's Falls, they were jammed into a hopeless mass, wedged firmly amid the crags. Down came the myriads of logs hurrying from upstream. The cliffs were lined with eager spectators of a scene that meant ruin to many of them; but what mortal power could stay that impetuous march? The jam was piled as high as the suspension bridge spanning the falls. Above the bridge the mass extended, very much resembling the glacier of the Rhone in shape—a glacier of logs instead of ice—for the distance of nearly three miles. I traversed it from end to end, measuring at various points, reaching the conclusion that the average thickness was about thirty feet, and the average breadth about three or four hundred feet. In several places, owing to the force of some whirlpool or the obstruction of jutting rocks or little islands, the logs are heaped up to the height of forty feet. In other places eye witnesses told me that they saw the strong current suck hundreds of logs under the upper mass, burying them in the waters below. Strange sights are to be seen. Here is a log caught by one end, and the other reared high in midair, like a huge flagstaff. There the case is reversed, and you just see the end of some log, whose length is vertically plunged into the mass below. Of course, the logs are of every size, from that of a telegraph pole to monstrous specimens sixty feet long and four feet through. And these are tossed about at every possible angle. Here and there may be seen some unfortunate log that was snapped in twain by being caught at a disadvantage.

As soon as the jam was judged to be done forming, so as to make it safe to experiment with it, steamboats were brought up to attack its lower end, in a faint hope of breaking it so as to cause a general drive. This was partly accomplished so as to clear the mass away that hung below the bridge, and for some distance above it. But when the foot of the falls of St. Croix was reached, the work had to be done by other methods. Dynamite was tried; but the materials were so elastic as to prevent that powerful agent from accomplishing very marked results.

The sight is highly picturesque, as one now looks up the river, seeing as far as the eye can reach that huge mass of logs, lying so wildly in grotesque confusion between the black cliffs of basalt, while troops of lumbermen, all dressed in red flannel, swarm along the front of the jam. These men select the logs that will in their judgment be most likely to set loose a number of others. A cut is made by an ax, and a heavy iron hook driven in. Word is then sent ashore by a loud shout, and the drivers whip up their horses, four of which work at a time; the cable is drawn taut, and the log thus attacked is drawn out, unless too tightly wedged in. Sometimes it shoots out alone into the stream, and again it carries with it a dozen others, and perhaps same luckless lumberman tumbles in, and is rescued amid the merriment of his comrades. Now and then a submerged log suddenly leaps to the surface and into the air like a huge porpoise. Thus the work goes on of picking the jam to pieces.

There yet remains in it fully 150,000,000 feet of logs. It is impossible to form a safe conjecture as to the length of time that may be required to release this vast accumulation of material. Meanwhile a great fortune is locked up, and the plans of thousands of people may have to be modified for a year to come by reason of this unexpected and strange calamity. The general opinion seems to be that the great bulk of the jam will not stir before it is lifted by the freshets of next spring. There are, however, several dams up stream, which it is intended soon to open, in hopes that the artificial flood thus produced may have some effect. Thousands of visitors are attracted to the locality, the universal expression being that it is the most wonderful spectacle of the kind ever seen.

Since the above was written, a narrow passageway has been made through the center of the jam, and it is expected the work of opening the river will be accomplished in the course of a year.

Cold Hammering of Iron.

It either is or ought to be known to all practical men concerned in the working of wrought iron that if a piece of the very best and toughest iron is hammered in the process of forging until it ceases to be red hot, the effect of such cold hammering, as I may term it, is to cause the iron to become so brittle that it will in many cases break across in the process; or if it does not at that time, this process of cold hammering has so removed and destroyed its tenacity as to render it capable of being broken with the slightest blow. What renders the knowledge of the effects of such a process the more important is that in most cases we shall find that, in order to give the pieces of forged work the requisite finish and fine surface as they come from the hands of our workmen in that department, this very cold hammering and swaging, as it is termed, is required, the more so as it is by such a process that iron forgings are so finished from the hammer as to require the least possible labor after; and as every good workman in that department is anxious to turn his work out of hand with the very best surface on it, which this cold hammering enables him to do, it is not a very easy matter, and not at all desirable, to require them to discontinue the practice, which many have endeavored to do from want of a full knowledge of the subject.

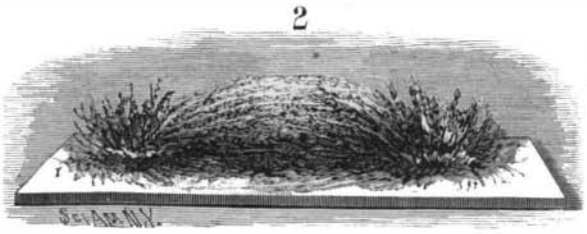
There is nothing inherently wrong in this practice of cold hammering—far otherwise; the evil rests with the applying such a cold hammered piece of forge work to its purpose without having been passed through the curative process, which is simply this, namely, to heat the piece of forged work in question to a dull red heat, and lay it down to cool at its leisure. By subjecting wrought iron to the most violent hammering or compression at a low temperature, and then submitting the iron work so treated to the simple process of heating red hot and slow cooling, we enhance its tenacity or shock-sustaining qualities at least twenty times.—*J. Nasmyth, in the Architect.*

The Microscope.

It is often a matter of question with the beginner what objects shall be examined with the microscope.

The answer, roughly speaking, would be *everything;* for whatever is not already small enough, can by proper treatment be reduced to the proper dimensions. For this purpose Nature has a great storehouse of hidden treasures, which she is ever ready to render up to the diligent seeker. Field and woodland, hill and valley, earth and water, are ever at hand, teeming with wonders, many of which, too minute for the eye of man, only reveal their beauties to the microscope—the king of the invisible.

If you understand taxidermy, you will find that the birds and mammals which you handle will afford abundant material for your microscope.



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MAGNETIC CURVES IN RELIEF.

Observe specimens of the feathers, hair, bones, and internal organs; the fresh fluids of the body (blood), the many parasites which may be found *on* and *in* all living creatures.

Sediments from various liquids may be examined, by placing a drop on a clean slide and covering.

Conical wine glasses are those best adapted for collecting sediments.

In this way the settlings of stagnant rain water, pools, etc., may be studied.

Very interesting material may often be collected in a little muslin bag tied to a faucet, through which the water is allowed to run slowly for an hour or two.

The common articles of food furnish exceedingly interesting specimens. Adulterations may thus be exposed after a little practice. The microscopic examination of drinking fluids often determines whether they are fit for use or not, by revealing the animal or vegetable matter which they may contain.

The insect world offers a delicate and beautiful anatomy for study. Observe the 7,000 divisions in the compound eye of the house fly; the delicate scales from the wings of moths and butterflies; the trachea, or breathing tubes; the suckers on a fly's foot; and hundreds of other parts.

Wonderful things are open to us in the world of plants. The structure, growth, and development of vegetable life are alone enough to keep one busy for years.

Thin scales of minerals may also be examined, thus adding much to the interest of that branch of science.

But these things are not always at hand or to be had, therefore specimens whenever obtained should be preserved for future use. Prepare during the summer for the winter's work. "Take time by the forelock," and whenever you see anything which you think may be of interest, label and preserve it.

Animals and birds, if small, may be placed whole in a seventy per cent solution of alcohol, first making an opening into the abdominal cavity, to allow the fluid ready access to the internal parts. Hair, feathers, and the like may be placed in envelopes properly labeled. Parasites, small insects, etc., may be placed in spirits in homœopathic pill bottles. Intestinal parasites from birds and small mammals may be obtained by slitting the intestine open in a dish of water.

The above are a few examples of materials easily within the reach of one possessing a microscope. With patience and perseverance the beginner will soon acquire a knowledge of the microscope and microscopic technique that will always prove a source of pleasure and profit.

In this busy life we cannot spend too much time observing Nature and learning her ways. "People grow better," says Daudet, "for listening to Nature, and those who love her do not lose their interest in men."

Whatever brings us closer to Nature's heart, brings us nearer to that Supreme Being who has created all things.—*W. P. Manton.*

The Size of the Spider's Thread.

I have often compared the size of the thread spun by full grown spiders with a hair of my beard. For this purpose I placed the thickest part of the hair before the microscope, and from the most accurate judgment I could form, more than a hundred of such threads placed side by side could not equal the diameter of one such hair. If, then, we suppose such a hair to be of a round form, it follows that ten thousand of the threads spun by the full grown spider, when taken together, will not be equal in substance to the size of a single hair.

To this if we add that four hundred young spiders, at the time when they begin to spin their webs, are not larger than a full grown one, and that each of these minute spiders possesses the same organs as the larger ones, it follows that the exceedingly small threads spun by these little creatures must be still four hundred times slenderer, and consequently that four millions of these minute spiders' threads cannot equal in substance the size of a single hair. And if we further consider of how many filaments or parts each of these threads consists, to compose the size we have been computing, we are compelled to cry out, O what incredible minuteness is here, and how little do we know of the works of Nature!—*Leuwenhoek, in* 1685.

THE FORMATION AND FIXATION OF MAGNETIC CURVES.

BY GEO. M. HOPKINS.

A great deal may be learned about the properties of magnets by causing them to delineate their own characteristics. The common method of doing this is to form magnetic curves by dusting iron filings on a glass plate, then jarring the plate to cause the particles to arrange themselves parallel with the lines of force extending from the magnetic poles. The figures thus formed are not, of course, entirely autographic; and as they tend to develop in lines, they convey the erroneous idea that the lines of force, as spoken of in connection with magnets, are really separate lines or streams of force.

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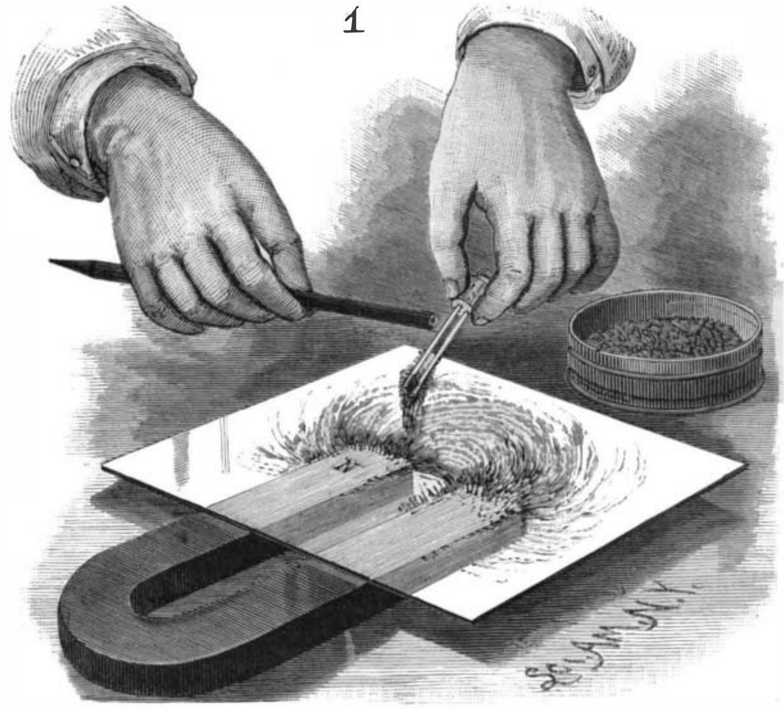

THE FORMATION OF MAGNETIC CURVES.

There is no way of exactly representing the magnetic field of force by forms or figures; but the annexed engravings serve to illustrate a method of forming and fixing curves which has some advantages over the method referred to above. The magnetic particles fall in the position in which they are to remain, and no jarring is required.

To make a flat plate for lantern projection or individual use, a plate of glass flowed with spirit varnish is laid upon the magnet, and iron dust reduced from the sulphate, or fine filings, or dust from a lathe or planer, is applied by means of a small magnet in the manner indicated in Fig. 1. The small magnet in this case consists of two magnetized carpet needles inserted in a cork, with unlike projecting poles arranged about one-quarter inch apart. A little of the iron dust is taken up on the small magnet, and the slightly adhering particles are shaken off. The remaining portion is then disengaged from the small magnet by rapping the magnet with a pencil, the small magnet being held above the poles of the larger one. The particles having been polarized by the small magnet, arrange themselves in the proper position while falling. Several applications of the iron dust will be required to complete the figure. Of course the iron must be applied before the varnish dries, and the plate should be allowed to remain on the magnet until dry.

To make the curves in relief, as shown in Fig. 2, a slightly different method is employed. The glass plate is warmed, coated with paraffine, and allowed to cool. It is then placed on the magnet, and proceeded with as in the other case. With care the curves can be built up high, especially if the larger magnet be a strong one. Iron filings or turnings of medium fineness are required in this case.

When the curves have assumed the desired proportions, a few very fine shreds of paraffine, scraped from a paraffine block or candle, are deposited very gently on the curves, and melted by holding above them a hot shovel. More shreds are then added and the hot shovel is again applied, and so on until the mass of iron filings is saturated with paraffine, when it is allowed to cool. The plate to which the filings are now attached may be removed from the magnet after having applied the armature, if it be a permanent magnet, or after interrupting the current, if it be an electro-magnet, when the curves will retain their position.

The arborescent figures shown in Fig. 3 are built upon a cap, or perhaps, more properly, on a double-crowned hat of brass, which incloses the poles of the magnet separately. The magnet in this case is arranged with its poles downward. The fixing of these curves is somewhat difficult, on account of being obliged to work under the rim of the hat, but it can be accomplished by proceeding in the manner described. Instead of the hot shovel, an alcohol lamp or Bunsen burner may be used in this case, but considerable care is required to prevent the iron dust from burning. The figure after cooling may be removed from the magnet, and preserved.

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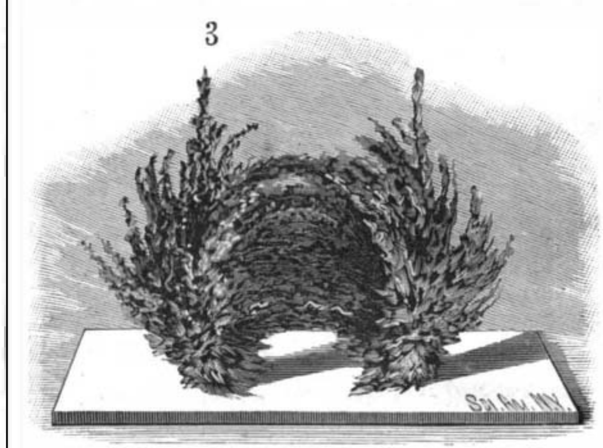

ARBORESCENT MAGNETIC FIGURES.

DOMESTICATION softens the whole organic structure. In the feathered species the feathering is not as dense nor as hard as on the wild fowl.