vessel. Two large gangways of extra width, provided with cranes, are also formed at each side for the landing of heavy timbers, plates, etc. The open sides admit of the air and light circulating freely round the work, so that paint dries and hardens much more quickly than in a sunken dock. From the same cause, repairs can be executed in a much more prompt and satisfactory manner than in a stone dock.

In exposed positions, it is proposed to submerge the dock entirely whenever it appears to be endangered by a cyclone or by stress of weather. The tubular sides afford great facilities for this operation; compressed air is pumped into them at leisure and kept stored up ready for use; after the dock is submerged, the opening of the valves will at any time allow it to expand and raise the dock to the surface. This use of stored-up power is also employed whenever it is desired to raise vessels rapidly—as, for example, in examining bottoms or screws; the power being stored up and ready for use, the dockingof a vessel occupies but little time; by opening communication with the water in the tubes, the air expands and expels the water, and the vessel is immediately raised.

Fig. 1 shows a general elevation of the dock, with a vessel supported upon it by bilge blocks and shoring frames; Fig. 2 shows an end elevation and section of the same.

The floating dock appears to occupy an intermediate place between the old stone graving dock and the hydraulic lift dock. Where the number of vessels to be lifted is very great, preference will probably be given to the latter; but the floating dock has advantages of its own. In the first place, its greatly reduced cost renders it suitable for many positions in which the business is insufficient to warrant the cost of a stone dock or an hydraulic lift dock. There are several cases in which floating docks of the ordinary construction are paying dividends of 20 or 30 per cent, in positions in which stone docks would be impossible, or in which their cost would entirely preclude their adoption. It is not always easy to find a suitable position for an ordinary graving dock, and even the hydraulic lift system requires water of a certain limited depth; but a floating dock can be placed anywhere where there is sufficient depth for a vessel to approach, and can be transported from place to place. It has been stated that the tubular dock is raised and lowered by pneumatic means; there is, of course, no theoretical reason why it should not be worked by ordinary water pumps in the usual manner.

Floating docks appear likely to be applied in future to another purpose, to which sufficient attention has hitherto not been drawn. We allude to their employment as building slips for the construction or lengthening of vessels. On the ordinary system it is necessary that a building yard should be closely adjoining deep water, and that the vessel should be constructed and launched on inclined ways, a process not always devoid of risk. By building on pontoons this risk is almost entirely avoided; any shallow river or creek may be utilized, whatever its distance from deep water, and the ways may be laid on a pontoon, either floating in shallow water or resting on the ground in a shallow dry dock temporarily prepared for the purpose; and when the vessel is ready for launching, the water may be admitted to the dock, the valves closed, and the vessel floated out into deep water. In fact, floating docks have not yet assumed their proper place in the naval service. Constructed often in a temporary manner of wood or iron, and from imperfect designs, they have sometimes met with indifferent success or even with disaster; but experience has shown at once both their defects and their merits, and there is no doubt they are destined in future to become one of the most important elements both in navigation and in naval construction.—*Naval Science.*

Correspondence.

The Second Mill River Disaster.

To the Editor of the Scientific American:

I have seen, in one of your city papers, concerning the late break in Hayden, Gere & Co.'s dam on Mill river, the question: If a dam constructed as this one was is not safe, what can be built that will stand?

The dimensions of the dam as stated were: Length 141 feet; width at base, 13 feet; width at top, 6 feet; head of water, 20 feet. I consider those proportions entirely inadequate for that head of water. A dam for a head of 20 feet should have at least 30 feet width of base up stream, from a right angle with the breast or break-over of the water; and whatever width is given to the wall on top must be added to the length of base, thus: If the wall is 6 feet wide at top, the base must be 36 feet, provided the front wall is plumb; if it is angled, the base must be made still wider to suit; but the main things are to make the base up stream at least 1½ feet for every foot in hight of head, and to make the upper wall or sheeting as tight as possible, leaving the front comparatively open; for if the front wall is made perfectly tight and the other loose or open, the pressure really comes on the front wall, as the balance of the work is made much lighter by being in the water. By this way of building a dam, the weight of the water bears down on the work and not against it, as it does on a wall narrow at the base.

We have a dam here, built in 1852. It is 100 feet between the abutments, with a head of 20 feet. It is built of pine timber, on the above described principle; but it is constructed of trestle work, each trestle being entirely independent of the others, except as to sheathing plank laid across them; and they are in no way anchored to the abutments. It has never needed any repairs, and has never shown the least sign of moving. A. W. IRWIN.

Arroyo, Elk county, Pa.

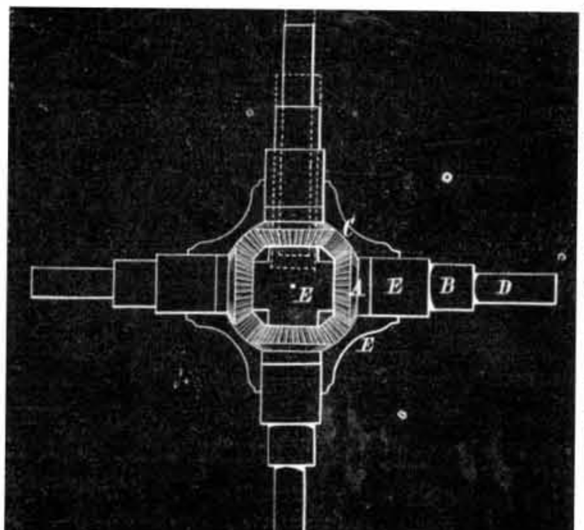
Placing Engine Cylinders in Line.

To the Editor of the Scientific American:

I notice a query in a late issue of your journal as to the best method of placing locomotive cylinders in line.

The most approved modern practice leaves but little to do in placing a cylinder in line, either in stationary or locomotive work, after the cylinder and its bedpiece leave the lathe and planer, except to test the accuracy of the draftsmen and machinists. If the machinists have accurate vertical and horizontal plan drawings for their guide, and work exactly accordingly, no after cutting or trimming will be needed to bring the cylinder into line. In locomotive work, one of the most difficult jobs is to fit the bedpiece to the boiler so that the two faces, upon which the cylinders are to be bolted, shall be exactly in their true position, which are usually indicated to the workman by the drawings.

In order to test the accuracy of the work after the bedpiece has been permanently fixed to the boiler, clamp a cylinder to its seat on the bedpiece and fit a wooden cross (with a pin hole through its center) to the bore of the cylinder at its front end; then pass a fine strong line through the hole, and extend it back so that it shall occupy a point exactly at the intersection of the central line of the driver axle with the vertical plane of motion of the center of the crank pin and con-



necting rod: draw the line taut and fasten it in this position; then apply calipers or a gage at the rear end of the cylinder, between the surface of the bore and the line, above and below and right and left of the line; and if the cylinder is in line, the four distances will of course be exactly the same. It is essential that the two horizontal distances should coincide exactly, and that the central lines of the two cylinders of a locomotive should be exactly parallel with each other, but for obvious reason the exact coincidence of the two vertical distances is not essential to the efficiency or correct working of the engine.

Instead of a wooden cross, as above mentioned, a more convenient instrument, made of metal, may be provided, consisting of four bevel gears, A, which serve also as nuts, which work four sockets, B, with threads cut on their inner ends, all neatly fitted to a light casting, E, having a fine central hole for the line, as shown. A central gear, C, works the four gears, of course all at the same time. Several sets of steel rods, D, may be provided if necessary, of different lengths, and thus render the instrument universal in its application, each set of rods serving for cylinders varying two inches, more or less, in the diameters of their bores.

To determine whether a cylinder of an old engine is in line: Remove the front head of the cylinder, the piston, the stuffing box gland, and the crosshead; apply the cross and line, as above directed, extending the line, through the piston rod hole in the rear head, to a point exactly central with the crank pin when the crank is at its dead point; draw the line taut, and, if the cylinder is correctly in range, the line will occupy a central position in the stuffing box, which may be determined as before directed. If the crosshead guides are parallel with the line, both vertically and laterally, they are also correct. F. G. WOODWARD.

Worcester, Mass.

Grit Wanted.

To the Editor of the Scientific American:

Little things in universal use, like the American postal card, are often of great importance. A small portion of silica or alumina, or any other grit, added to the sizing, would convert our cards into tablets which could be written upon with a metallic point, and from which no ordinary friction will erase the writing. The writing with the metallic point would also be more legible than the writing with most inks or pencils.

The addition of the small amount of grit required does not injure the surface for writing with a pen, and could not add appreciably to the expense of their manufacture. The government furnishes the cards. Let it furnish also miniature metallic-pointed pencils for the vest pocket at one cent a piece. The government would make money by doing so, and a single pencil would carry on an ordinary citizen's card correspondence for a year.

These metallic points should be made of lead with a small percentage of bismuth. There are two ways of making such pencils. A cylinder of the alloy two inches long and one eighth of an inch in diameter can be wound with fancy paper until the diameter equals one sixth of an inch; the paper might be put on wet, compressed in a mold (*maché*) and varnished. Or a polished wooden cylinder, two and a half inches long and one fifth of an inch in diameter, can have a metallic point inserted at one end in the common way.

The present postal card can be written on with a soft metal point, but not with an alloy hard enough to give a fine, black, permanent mark. W. F. C.

Small Steam Engines.

To the Editor of the Scientific American:

I will give you the result of my experience with a smal boat engine, the vessel being 47 feet long, 11½ feet wide, and 4½ feet deep. She has a three-bladed screw, 4½ feet in diameter with 6 feet pitch, which is made to rise or fall in the water. The engine has two 6 x 10 inches cylinders, running at 120 revolutions per minute, with 70 lbs. steam. The engine exhausts into 75 feet of two-inch pipe, 60 feet of which is in the water outside of the boat, coming in again to conduct the water to the hot well. The pump takes the water to the boiler at 190° Fah. This arrangement makes a very good condenser. The boiler is 7½ feet x 4½ feet, with 120 two-inch tubes.

I have with this boat towed a ship of 700 tuns at 4 miles an hour, with 60 lbs. of coal per hour, and I can make 9 miles an hour when not towing. The mistake generally made by those who have not had experience with boat engines is that they do not give sufficient boiler capacity; and I find that the ample boiler power above described gives an excellent result as to fuel consumption with my small engine.

P. M. BLATCHLEY.

Guilford, Conn.

Splicing Large Belts.

To the Editor of the Scientific American:

There is in the Upper Mills here, in which I am engaged, a 26 inch, 8 ply rubber belt, doing the following duty: It runs off the fly wheel of a 24x48 inch engine, the fly wheel being 18 feet in diameter and making 65 revolutions per minute, driving an overhead line of shafting and two lines at right angles to it, said shafting driving two 8 inch guide mills by an 18 inch rubber belt to each, one at 230, the other at 280, per minute. Each mill finishes sixteen tuns gross of finished iron every 24 hours. Two pairs little mill shears, one pair bar mill shears, and one 36 inch circular saw for hot iron are also driven by the main belt.

In the early part of last summer, an accident occurred by which the above mentioned belt was torn into several pieces and ripped into strips. Knowing that it was impossible to obtain a new belt without ordering it from the makers, we had to do the best we could with what we had; so we patched up a ragged-edged strip of the torn belt (averaging 12 inches wide), thinking to run a part of the above machinery with it. Some laughed at the idea of attempting to run any part of it with such a cord as that looked to be; but to the surprise of all, it performed the entire duty of the original belt, and in so satisfactory a manner that the new belt was on hand some four weeks before a favorable opportunity was afforded to put it on.

A member of the firm here adopted some years ago what was then a new way of fastening the ends of and splicing large belts; it has proved a cheap and reliable way, and is now in general use in this vicinity: Cut your belt perfectly square on the ends and to the proper length: then cut a piece of belt of the same width and thickness, about 3 feet long. Bring the ends of the belt together, and put the short piece on the back of the joint, or outside, and bolt the belt and piece together with what are known as elevator bolts, used for fastening the buckets to elevator bands. The tools required are a brace and bit to bore the holes and a small pair of blacksmith's tongs to tighten up the nuts with.

When a belt becomes dry or glazed, I have always found that a liberal dose of castor oil was a specific; and I have never known a belt to be mutilated by rats or other vermin if it had castor oil on.

Pittsburgh, Pa. T. J. B.

[For the Scientific American.]

A NEW METHOD OF MEASURING SURFACES, APPLIED TO THE CIRCLE.

The fact that the modern chemical balance gives a greater degree of accuracy in the determination of weights, and with much more facility than is the case with any other kind of measurement, especially that of curved lines, has given rise to a method of determining irregularly shaped surfaces of land in square miles or acres, by tracing them on paper of uniform thickness, cutting it out to the correct shape, and comparing the weight of the piece of paper thus obtained with that of a piece cut to the size of a square mile or of an acre, of the same kind of paper, to the same scale. By calculating how often the weight of the latter piece is contained in that of the former, it will give the number of square miles or acres contained in the land in question. This calculation consists, of course, in only a simple division. I can recommend this method fully, as, when carefully applied, it gives results the correctness of which is not surpassed by those of any other method whatsoever. This may be verified by taking regularly shaped forms, easily measured by the ordinary methods. I have in this way determined the surface of islands and continents in square miles, of farms in acres and rods, etc., and am compelled to testify that the method is far superior, in the correctness of its results, to that by means of the graphic method, with the help of Amsler's polar planimeter, now so excellently made in Switzerland and to be obtained in our large cities. The method by the help of the balance gives not much more trouble, less calculation, and less liability to error than the use of the instrument in question; and the latter costs almost half as much as a good chemical balance, which is therefore far to be preferred. The planimeter is, however, an instrument enclosed in a box which can be carried in the pocket, and this is an advantage it has over the balance.

In order to test the degree of accuracy which can be obtained by the use of the balance for this purpose, and at the same time practically to demonstrate the fallacy of the assertions of such circle squarers as Lawrence T. Benson, who maintains that the surface of a circle is equal to three fourths of the square of its diameter, I took a piece of paper of uniform thickness, not varying $\frac{1}{4000}$ of an inch from the average thickness of $\frac{7}{4000}$ of an inch, as tested by the micrometic screw used for determining the correct thickness of the covering glasses for microscopic objects to be examined by immersion objectives of very high power. From this paper a square of 12 inches was cut, and its weight found to be 3,511 milligrammes. A circle was then cut out of it, scrupulously made tangent to the sides of the square; its weight was found to be 2,757 milligrammes. This number, divided by the former, gives 0·7855, the quarter of the square 3,511 being 878·75, and three quarters, 2633·25 milligrammes. The actual weight of the circle, 2,757, is thus 123·75 milligrammes more than the weight of three quarters of the square, while the quotient, 0·7855, expressing the relation between the surface of the square and the circle, is remarkably near to the fourth part of the well known number 3·141592, etc., or 0·785398, etc., which latter expresses the ratio between the square of the diameter and the surface of the circle.

In order to find how far the method of weighing could approximate the true ratio, another experiment was made, in which the graduated arm of the balance was used, on which a so-called rider makes it possible to weigh to tenths of milligrammes. [The balance, by the way, is one of the very best of Becker & Sons', and indicates even one tenth of a milligramme when charged with 100 grammes in each scale; it is thus sensitive to $\frac{1}{2000000}$ part of the charge.] A piece of other paper, if possible superior in regard to uniformity of thickness, was cut into a square of 18 inches; its weight was found to be 7,644 milligrammes. The circle, carefully cut from it, tangent to the sides, had a weight of 6,003·5 milligrammes; this, divided by the formernumber, gives 0·785401, which differs from the theoretical and more correct number, 0·785398, by $\frac{3}{1000000}$ parts.

In order to have an additional test in regard to three quarters of the square of the diameter, the circular paper was folded in 16 radial lines, and 16 chords, spanning segments of 22° 45′ each, were drawn and cut so as to change the circle into the inscribed polygon of 16 sides. Its weight was found to be 5,851 milligrammes, which is 118 milligrammes more than three quarters of the square: $\frac{3}{4} \times 7,644 = 5,733$. It is thus seen that not only the circle cut from a square, but even its inscribed polygon of 16 sides, has a larger surface than three times the square of the radius, which, for the diameter $=1$, is expressed by 0·75, a number considerably smaller than the more correct expression 0·785398, used by all mathematicians, not because it is simply accepted as true, but because its accuracy has been demonstrated.

It can also be demonstrated that the figure representing correctly three fourths of the square of the diameter is the inscribed polygon of 12 sides. It is remarkable how this also can be verified by the balance in the above manner. For instance, on a square of paper of 15 inches side and 4,901·5 milligrammes weight, a tangent circle was drawn, and then an inscribed polygon of 12 sides. When the polygon was cut out, its weight was found to be 3,676, and the piece cut off around weighed 1,225·5 milligrammes: together, 4,901·5, of which 3,676 is very nearly three fourths.

The above details are not given as a demonstration. Mathematicians do not need experiments of this kind to see into a truth; but it is given only for the benefit of those whose minds are so constituted that they can perhaps only be convinced of their erroneous notions by a practical test, which any one who has a chance to use a good balance can easily make.

New York city. P. H. VANDER WEYDE.

The Electrolytic Preparation of Magnets.

The late Professor Jacobi proposed to determine experimentally whether, by proper arrangement, precipitated iron can be induced to arrange itself so as to form permanent magnets. The author maintains that he solved the question twelve years ago, and obtained magnets by electrolysis. He finds that iron precipitated from a solution of iron containing sal ammoniac is, in a very eminent degree, capable of permanent magnetism; that precipitated from other solutions of iron is magnetic only in a slighter degree. If the precipitate is obtained under the influence of powerful magnetism—prejudicial circumstances being avoided—strong magnets of homogeneous structure are formed from solutions containing sal ammoniac. On the other hand, solutions free from sal ammoniac yield magnets distinguished by their irregular structure, in consequence of which the feeble magnetism of the precipitate is rendered still weaker. A not unimportant degree of coercive power cannot, under any circumstances, be denied to iron, unless altered in its structure by ignition or other processes. The nature of the solutions themselves must be regarded as the cause of the irregularities of structure. While the sal-ammoniacal solution remains perfectly clear, a solid crystalline layer is separated upon its surface. If pieces are broken off, they fall to the bottom. Solutions of ferrous chloride become turbid, and continually deposit a slimy precipitate upon the electrodes. Klein's solution remains tolerably clear, but upon the surface is formed a slimy foam. If any of this falls down, the electrodes are likewise soiled. Thus the iron precipitate is deprived of its homogeneity, and by partial removal of the impurities—for example, by brushing and by the rise of gas bubbles—the formation of partial magnets is explained.—*W. Beetz, in Poggendorff's Annalen.*

Japanese Paper Clothing.

In the Japanese exhibit at the Vienna Exposition was displayed a remarkable variety of objects of common use made entirely from paper, the mode of manufacture of which has hitherto been unknown out of Japan. The articles included handkerchiefs, napkins, garments, lanterns, umbrellas, and many others, all made from a fabric noticeable for its strength and solidity.

A member of the German Society of Orientalists, M. Zappe, has recently explained the process by which this paper is produced. The material used is the bark of the *Broussonetia papyrifera* or paper mulberry, the same source from which the natives of Polynesia derive their tapa cloth and mats, though treated in an essentially different manner.

The culture of the plant is quite simple. Pieces of root, some three inches in length, are placed in the earth so as to protrude slightly above the surface. These speedily send forth shoots, often of nine inches in length during the first year, and increasing threefold in size during the following twelve months. By the end of the third year, the plant attains a hight of about thirteen feet, and by careful pruning is eventually brought to a broad and strong shrub.

In winter, the branches are removed and chopped in bits about two inches in length, which are boiled in water until the bark comes off readily in the hand. Drying of the bark in the air for two or three days follows; and after immersion in running water for twenty-four hours, the material is scraped on a cutting blade so as to separate the two kinds of fibers of which it is composed. The exterior fibers are of dark color, and are called "*saru kawa*"; they serve to make paper of inferior quality.

The interior filaments, known as "*sosori*", which are used for fine paper, are rolled in balls weighing some 35 lbs. each. These are washed in running water and left to soak for a short time, after which they are removed and squeezed dry. Boiling then follows, in a lye made from the ashes of buckwheat bran, care being taken that the contents of the vats are constantly stirred. Another washing in water removes all remaining impurities, and the fibers are then pounded, for twenty minutes at a time, upon blocks of hard wood. They are finally massed into balls, and these, by ordinary means, made into pulp. Into the latter a small proportion of a liquid extracted from the root of the *hebiocus manihot* is mixed, and a quantity of rice water, to prevent the ravages of insects. The subsequent treatment of the pulp is similar to the usual process of paper-making.

Leather paper, so called, is made by the superposition of several sheets of the material previously soaked in an oil derived from the *yonoko* (*cellis Wildenowiana*), subjected to strong pressure, and lastly covered with shellac. Clothing is made from a paper called "*shefu*", which is cut into threads more or less fine according to the fabric to be produced. These are twisted by the fingers, previously moistened with milk of lime, and are woven into cloth either alone or with silk. The stuff can be washed and is of great strength and durability. *Papier crêpé*, so called by the French from its having the wrinkled appearance of crape, is produced by moistening the sheets and pressing them under rollers having suitable corrugations on their peripheries.

Astronomical Discoveries in 1874.

Professor Daniel Kirkwood gives the following *resumé* of new heavenly bodies discovered during the year just ended.

Six minor planets have been added to the list:

No. 135, discovered by Dr. C. H. F. Peters, February 18, at Clinton, N. Y.

No. 136, by Palisa, at Pola, Prussia, March 18.

No. 137, by the same, April 21.

No. 138, by Perrotin, at Toulouse, May 19.

No. 139, by Professor Watson, at Pekin, October 8.

No. 140, by Palisa, at Pola, as above.

Four comets were also discovered, the most interesting of which, Coggia, we have fully described. The star shower of November 14 entirely failed, and no further return of the meteors in any considerable number can be expected until near the close of the century.

It has been found that the aphelion of Mars differs in longitude but one degree from the perihelion of the minor planet Aethra, discovered in 1873: and that the greatest distance of the former exceeds the least of the latter. These facts indicate the possibility of so near an approach of the two bodies that the disturbing influence of Mars on the asteroid may materially modify its orbit.

New Postal Car.

The Lake Shore railroad has had under construction for some time, and has just completed, at their car works in Adrian, a postal car of a new pattern, intended especially for newspaper work. It has already been put upon the route between Chicago and Buffalo. The car has been built partially as an experiment, and partially from a knowledge of what the service demands. It is 60 feet and 6 inches in length, and weighs 49,300 pounds. It contains 122 distributing boxes in the center of the car, while the ends are arranged for the convenient storing away of the filled sacks. Besides these, the car is fitted up with all the modern conveniences for the rapid and easy disposition of the work. There is room for two men to work; and it is expected that with the convenience afforded they can conduct newspaper distribution as expeditiously as that of letters.

Beginners.

BY PROFESSOR H. VOGEL.

Old and young, when they take up photography, have generally no ideal purpose in view beyond the practical project of gaining their daily bread with the aid of the camera. They care very little for the chemical reactions, or the action of the light, or the disposition of molecules, etc., and less still abont the question whether photography is really an art or not; their object is to create a good business, and this goal they try to reach as quickly as possible. Generally speaking, they begin by undergoing a few weeks' tuition under some other photographer, where they learn to coat a plate in a passable manner.

I am often asked how long is really necessary in learning to become a photographer, and I always reply that the matter very much depends upon the individual himself. Those who possess a knowledge of chemistry, and have natural aptitude, will learn to take negatives in a very short time. I could mention a well known scientific man who studied my manual carefully, and came into my studio impressed with a good deal of technical knowledge of the matter, therefore, and under these circumstances there was really nothing for him to learn but the practical manipulations, the pouring on of the collodion, developer, etc., and the adjustment and working of the apparatus, things obviously that can only be taught by demonstrations. This gentleman was qualified to operate in five days. Of course during this short period he had not been looking on with his hands in his pockets, lounging about under the impression that he knew enough; but he practised at home what he learned from day to day, and was exceedingly successful in what he did.

Another pupil that I had, who was an exceedingly good chemist, and thoroughly acquainted with the materials which he had to manipulate, turned out quite the reverse, for, after six months' tuition, he was still a clumsy operator. He belonged to that numerous class which are usually termed "butterfingers." When he took up a plate to clean it, it slipped through his fingers; the dipper he would infallibly break after one or two experiments; the developer ran off the plate, and the filter never acted under any circumstances. I was exceedingly glad to get rid of so awkward a pupil, for I could never have made anything out of him. These two are, of course, merely instances, and do not hold good in all cases

There are people who enter a studio without any previous knowledge, and who are exceedingly quick at picking up the first rudiments of the art. In a week they are so self-satisfied that they hasten home to follow up their success, but, unfortunately, find themselves stuck fast in a day or two over a question about which they possess no experience.

The matter is easily explained. It is easy enough, when you have good plates prepared for you, good collodion, good dipping bath, good developers, intensifiers, etc., to secure a good picture, especially when found in a well regulated studio; success is here obtained without difficulty; but the beginner has to thank the pure chemicals and the photographer who has prepared the baths and solutions for it, for he does not know how soon these may become changed after working or standing some time. He finds that the collodion, especially if the drainings go back into the bottle, becomes thicker and thicker; it gathers dust and impurities, and thus spots and stains are produced, whose presence he is unable to explain from his eight days' apprenticeship. It is the same with the dipping bath. Unfortunately a bit of lime or kaolin has fallen into the solution, and this has rendered it slightly alkaline, and at once the plates show signs of fogging; or again, the collodion is full of organic impurities, which produce streaks on the sensitive plate; or the film has other defects, such as pinholes, patches of insensitiveness, flatness, etc. All these phenomena, which may not come unexpectedly to those who have studied a photographic manual, are enough to confuse any beginner who relies upon his own brief experience in the matter. If to these well known defects we add, moreover, those that arise from faulty exposure or intensifying, bad fixing or varnishing, we have no inconsiderable host of disagreeables. I have pointed out in my manual as many as sixty different sources of failure, and this number is by no means complete. Those who desire to know something about these vexatious phenomena, and the means necessary for their avoidance, will not be able to finish their apprenticeship in a week, for it is only long practice and study that make the skillful photographer.

Dr. Jacobsen says that a little chemistry should belong to the culture of all men; and the photographer is a man. There are many operators who take excellent pictures, and yet boast that they know nothing of chemistry. This, however, is mere nonsense, for such people, if they have not studied chemistry theoretically, have been so long working with photographic chemicals, and observing the reactions, that they have become possessed of the chemical properties of the things employed. They know from experience that iodide of ammonium when decomposed gives off iodine, and becomes red; that iodine colors collodion yellow, and starch blue; that nitrate of silver is easily dissolved in water, and in alcohol only with great difficulty; that it freezes at a high temperature, and becomes decomposed in one still higher; that it dissolves iodide of silver; that it is reduced by organic substances, etc.

In the building up of this practical knowledge piecemeal, of course many a pint of collodion is lost, many a costly silver bath thrown into the residue pan, and much valuable time frittered away in aimless experiments. The same amount of chemical knowledge they could have acquired in a tenth part of the time and tenth part of the cost by studying photographic chemistry; and this knowledge is readily acquired, for photographic chemistry occupies but a small section in the thick manuals on organic and inorganic chemistry.—*Photo. News*