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PETROLEUM AND COAL IN VENEZUELA.

MR. E. H. PLUMACHER, U. S. Consul at Maracaibo, sends to the State Department the following information touching the wealth of coal and petroleum probable in Venezuela:

The asphalt mines and petroleum fountains are most abundant in that part of the country lying between the River Zulia and the River Catatumbo, and the Cordilleras. The wonderful sand-bank is about seven kilometers from the confluence of the Rivers Tara and Sardinarte. It is ten meters high and thirty meters long. On its surface can be seen several round holes, out of which rises the petroleum and water with a noise like that made by steam vessels when blowing off steam, and above there ascends a column of vapor. There is a dense forest around this sand-bank, and the place has been called "El Inferno." Dr. Edward McGregor visited the sand-bank, and reported to the Government that by experiment he had ascertained that one of the fountains spurted petroleum and water at the rate of 240 gallons per hour. Mr. Plumacher says that the petroleum is of very good quality, its density being that which the British market requires in petroleum imported from the United States. The river, up to the junction of the Tara and Sardinarte, is navigable during the entire year for flat-bottomed craft of forty or fifty tons.

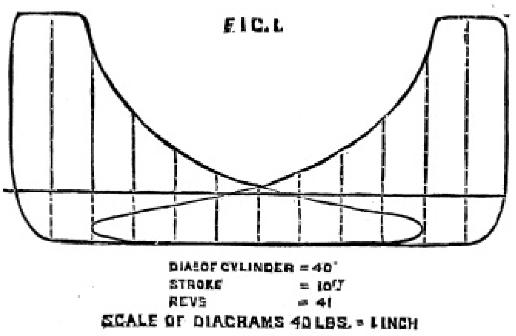
Mr. Plumacher has been unable to discover that there are any deposits of asphalt or petroleum in the upper part of the Department of Colon, beyond the Zulia, but he has been told that the valleys of Cucuta and the territories of the State of Tachira abound in coal mines. There are coal mines near San Antonia, in a ravine called "La Carbonera," and these supply coal for the smiths' forges in that place. Coal and asphalt are also found in large quantities in the Department of Sucre. Mr. Plumacher has seen, while residing in the State of Zulia, but one true specimen of "lignite," which was given to him by a rich land-owner, who is a Spanish subject. In the section where it was found there are several fountains of a peculiar substance. It is a black liquid, of little density, strongly impregnated with carbonic acid which it transmits to the water which invariably accompanies it. Deposits of this substance are found at the foot of the spurs of the Cordilleras, and are believed to indicate the presence of great deposits of anthracite.

There are many petroleum wells of inferior quality between Escuque and Bettijoque, in the town of Columbia. Laborers gather the petroleum in handkerchiefs. After these become saturated, the oil is pressed out by wringing. It is burned in the houses of the poor. The people thought, in 1824, that it was a substance unknown elsewhere, and they called it the "oil of Columbia." At that time they hoped to establish a valuable industry by working it, and they sent to England, France, and this country samples which attracted much attention. But in those days no method of refining the crude oil had been discovered, and therefore these efforts to introduce petroleum to the world soon failed.

The plains of Ceniza abound in asphalt and petroleum. There is a large lake of these substances about twelve kilometers east of St. Timoteo, and from it some asphalt is taken to Maracaibo. Many deposits of asphalt are found between these plains and the River Mene. The largest is that of Cienega de Mene, which is shallow. At the bottom lies a compact bed of asphalt, which is not used at present, except for painting the bottoms of vessels to keep off the barnacles. There are wells of petroleum in the State of Falcon.

Mr. Plumacher says that all the samples of coal submitted to him in Venezuela for examination, with the exception of the "lignite" before mentioned, were, in his opinion, asphalt in various degrees of condensation. The sample which came from Tule he ranks with the coals of the best quality. He believes that the innumerable fountains and deposits of petroleum, bitumen, and asphalt that are apparent on the surface of the region around Lake Maracaibo are proof of the existence below of immense deposits of coal. These deposits have not been uncovered because the territory remains for the most part as wild as it was at the conquest.

ONE THOUSAND HORSE-POWER CORLISS ENGINE.



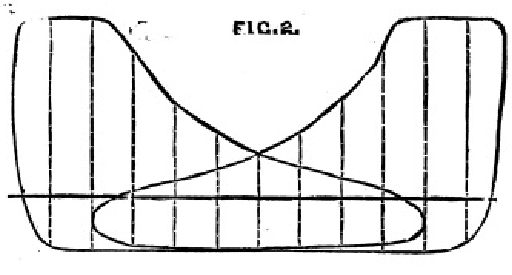
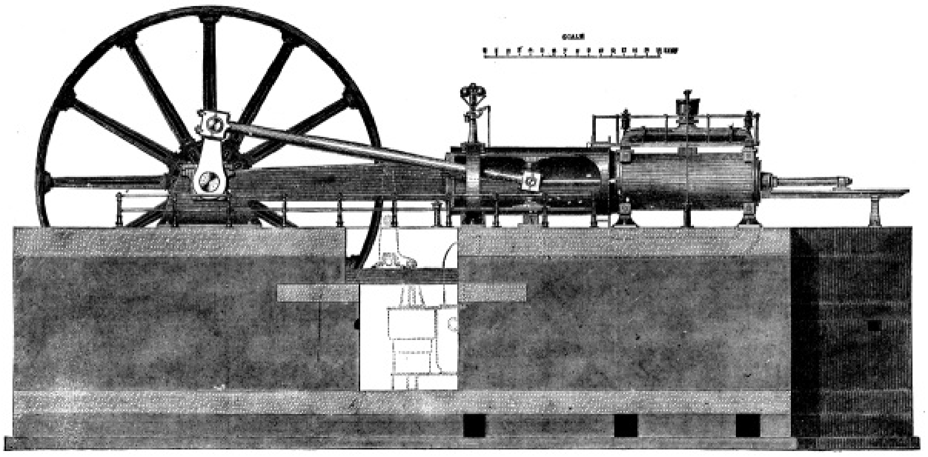


FIG. 1.

DIA. OF CYLINDER = 40''
STROKE = 10 ft.
REVS = 41
SCALE OF DIAGRAMS 40 LBS = 1 INCH

FIG. 2.

We illustrate one of the largest Corliss engines ever constructed. It is of the single cylinder, horizontal, condensing type, with one cylinder 40 inches diameter, and 10 feet stroke, and makes forty-five revolutions per minute, corresponding to a piston speed of 900 feet per minute. At mid stroke the velocity of the piston is 1,402 feet per minute nearly, and its energy in foot pounds amounts to about 8.6 times its weight. The cylinder is steam jacketed on the body and ends, and is fitted with Corliss valves and Inglis & Spencer's automatic Corliss valve expansion gear. Referring to the general drawing of the engine, it will be seen that the cylinder is bolted directly to the end of the massive cast iron frame, and the piston coupled direct to the crank by the steel piston rod and crosshead and the connecting rod. The connecting rod is 28 feet long center to center, and 12 inches diameter at the middle. The crankshaft is made of forged Bolton steel, and is 21 inches diameter at the part where the fly-wheel is carried. The fly driving wheel is 35 feet in diameter, and grooved for twenty-seven ropes, which transmit the power direct to the various line shafts in the mill. The rope grooves are made on Hick, Hargreaves & Co.'s standard pattern of deep groove, and the wheel, which is built up, is constructed on their improved plan with separate arms and boss, and twelve segments in the rim with joints planed to the true angle by a special machine designed and made by themselves. The weight of the fly-wheel is about 60 tons. The condensing apparatus is arranged below, so that there is complete drainage from the cylinder to the condenser. The air pump, which is 36 inches diameter and 2 feet 6 inches stroke, is a vertical pump worked by wrought iron plate levers and two side links, shown by dotted lines, from the main crosshead. The engine is fenced off by neat railing, and a platform with access from one side is fitted round the top of the cylinder for getting conveniently to the valve spindles and lubricators. The above engraving, which is a side elevation of the cylinder, shows the valve gear complete. There are two central disk plates worked by separate eccentrics, which give separate motion to the steam and exhaust valves. The eccentrics are mounted on a small cross shaft, which is driven by a line shaft and gear wheels. The piston rod passes out at the back end of the cylinder and is carried by a shoe slide and guide bar, as shown more fully in the detailed sectional elevation through the cylinder, showing also the covers and jackets in section. The cylinder, made in four pieces, is built up on Mr. W. Inglis's patent arrangement, with separate liner and steam jacket casing and separate end valve chambers. This arrangement simplifies the castings and secures good and sound ones. The liner has face joints, which are carefully scraped up to bed truly to the end valve chambers. The crosshead slides are each 3 feet 3 inches long and I foot 3 inches wide. The engine was started last year, and has worked beautifully from the first, without heating of bearings or trouble of any kind, and it gives most uniform and steady turning. It is worked now at forty-one revolutions per minute, or only 820 feet piston speed, but will be worked regularly at the intended 900 feet piston speed per minute when the spinning machinery is adapted for the increase which the four extra revolutions per minute of the engine will give; the load driven is over 1,000 horsepower, the steam pressure being 50 lb. to 55 lb., which, however, will be increased when the existing boilers, which are old, come to be replaced by new. Indicator diagrams from the engines are given on page 309. The engine is very economical in steam consumption, but no special trials or tests have been made with it. An exactly similar engine, but of smaller size, with a cylinder 30 inches diameter and 8 feet stroke, working at forty-five revolutions per minute, made by Messrs. Hick, Hargreaves & Co. for Sir Titus Salt, Sons & Co.'s mill at Saltaire, was tested about two years ago by Mr. Fletcher, chief engineer of the Manchester Steam Users' Association, and the results which are given below pretty fairly represent the results obtained from this class of engine. Messrs. Hick, Hargreaves & Co. are now constructing a single engine of the same type for 1,800 indicated horse-power for a cotton mill at Bolton; and they have an order for a pair of horizontal compound Corliss engines intended to indicate 3,000 horse-power. These engines will be the largest cotton mill engines in the world.--*The Engineer*.



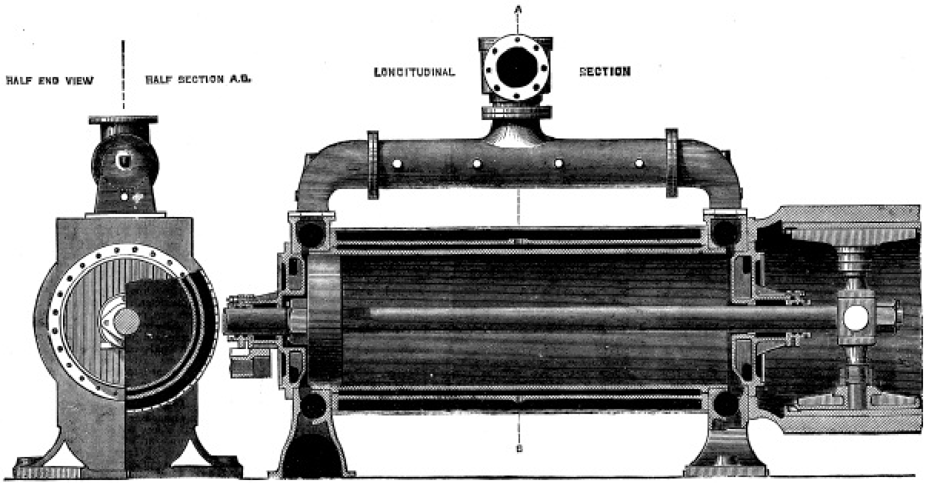
1000 HORSE POWER CORLISS ENGINE.--BY HICK. HARGREAVES & CO.

Result of Trials with Saltaire Horizontal Engine on February 14th and 15th, 1878. Trials made by Mr. L.E. Fletcher, Chief Engineer Steam Users' Association, *Manchester.*

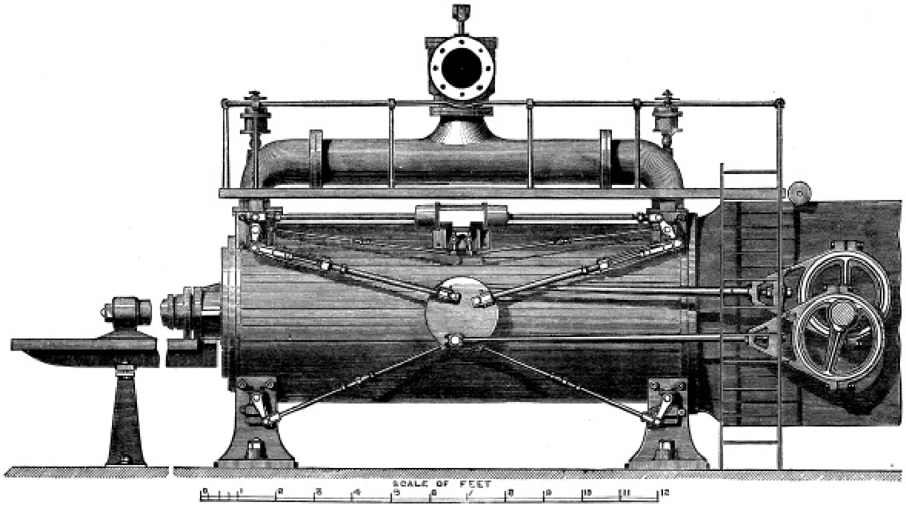
Engine single-cylinder, with Corliss valves. Inglis and Spencer's valve gear. Diameter of cylinder. 30in.; stroke, 8ft.; 45 revolutions per minute.

No. of trials
Total 1.H.P.
[MB] Mean boiler pressure.
[MP] Mean pressure on piston at beginning of stroke.
[ML] Mean loss between boiler pressure and cylinder.
[MA] Mean average pressure on piston.
[W] Water Per I.H.P. per hour.
[C] Coal per I.H.P. per hour.

No. of trials	Total I.H.P.	MB lb	MP lb	ML lb	MA lb	W lb	C lb
Trial No. 1.	301.89	46.6	44.11	2.53	21.23	18.373	2.699
Trial No. 2.	309.66	47.63	44.45	3.18	21.67	17.599	2.561
Means.	305.775	47.115	44.28	2.855	21.45	17.986	2.630



1000 HORSE POWER CORLISS ENGINE.--BY HICK, HARGREAVES & CO.



1000 HORSE POWER CORLISS ENGINE.--BY HICK, HARGREAVES & CO.

OPENING OF THE NEW WORKSHOP OF THE STEVENS INSTITUTE OF TECHNOLOGY.

In our SUPPLEMENT No. 283 we gave reports of some of the addresses of the distinguished speakers, and we now present the remarks of Prof. Raymond and Horatio Allen, Esq.:

SPEECH OF PROF. R. W. RAYMOND.

A few years ago, at one of the meetings of our Society of Civil Engineers we spent a day or so in discussing the proper mode of educating young men so as to fit them for that profession. It is a question that is reopened for us as soon as we arrive at the age when we begin to consider what career to lay out for our sons. When we were young, the only question with parents in the better walks of life was, whether their sons should be lawyers, physicians, or ministers. Anything less than a professional career was looked upon as a loss of caste, a lowering in the social scale. These things have changed, now that we engineers are beginning to hold up our heads, as we have every reason to do; for the prosperity and well-being of the great nations of the world are attributable, perhaps, more to our efforts than to those of any other class. When, in the past, the man of letters, the poet, the orator, succeeded, by some fit expression, by some winged word, to engage the attention of the world concerning some subject he had at heart, the highest praise his fellow man could bestow was to cry out to him, "Well said, well said!" But now, when, by our achievements, commerce and industry are increased to gigantic proportions, when the remotest peoples are brought in ever closer communication with us, when the progress of the human race has become a mighty torrent, rushing onward with ever accelerating speed, we glory in the yet higher praise, "Well done, well done!" Under these circumstances, the question how a young man is best fitted for our profession has become one of increasing importance, and three methods have been proposed for its solution. Formerly the only point in debate was whether the candidate should go first to the schools and then to the workshop, or first to the shop and then to the schools. It was difficult to arrive at any decision; for of the many who had risen to eminence as engineers, some had adopted one order and some the other. There remained a third course, that of combining the school and the shop and of pursuing simultaneously the study of theory and the exercise of practical manipulation. Unforeseen difficulties arose, however, in the attempt to carry out this, the most promising method. The maintenance of the shop proved a heavy expense, which it was found could not be lessened by the manufacture of salable articles, because the work of students could not compete with that of expert mechanics. It would require more time than could be allotted, moreover, to convert students into skilled workmen. Various modifications of this combination of theory and practice, including more or less of the Russian system of instruction in shop-work, have been tried in different schools of engineering, but never under so favorable conditions as the present. With characteristic caution and good judgment, President Morton has studied the operation of the scheme of instruction adopted in the Stevens Institute, and, noting its deficiencies, has now supplied them with munificent liberality, giving to it a completeness that leaves seemingly nothing that could be improved upon, even in a prayer or a dream. Still, no one will be more ready to admit than he who has done all this, that it is not enough to fit up a machine shop, be it never so complete, and light it with an electric lamp. The decision as to its efficiency must come from the students that are so fortunate as to be admitted to it. If such young men, earnest, enthusiastic, with every incentive to exertion and every advantage for improvement, here, where they can feel the throbbing of the great heart of enterprise, within sight of bridges upon which their services will be needed, within hearing of the whistles of a score of railroads, and the bells of countless manufactories which will want them; if such as these, trained under such instructors and amid such surroundings, prove to be not fitted for the positions waiting for them to fill, it will have been definitely demonstrated that the perfect scheme is yet unknown.

SPEECH OF MR. HORATIO ALLEN.

Impressed with the very great step in advance which has been inaugurated here this evening, I feel crowding upon me so many thoughts that I cannot make sure that, in selecting from them, I may not leave unsaid much that I should say, and say some things that I had better omit. Some years ago, when asked by a wealthy gentleman to what machine-shop he had best send his son, who was to become a mechanical engineer, I advised him not to send him to any, but to fit up a shop for him where he could go and work at what he pleased without the drudgery of apprenticeship, to put him in the way of receiving such information as he needed, and especially to let him go where he could see things break. Great, indeed, are the advantages of those who have the opportunity of seeing things break, of witnessing failures and profiting by them. When men have enumerated the achievements of those most eminent in our profession the thought has often struck me, "Ah! if we could only see that man's scrap heap."

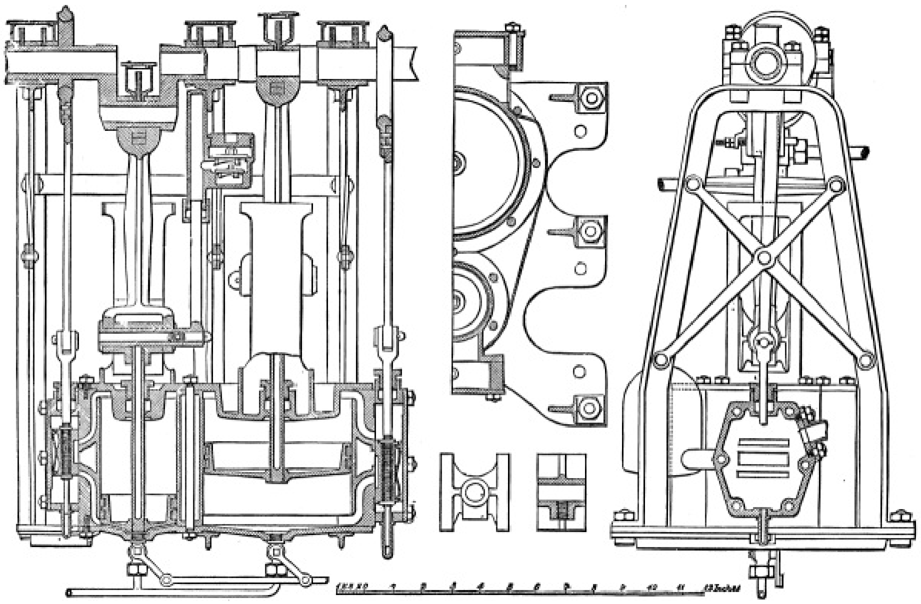
There are many who are able to construct a machine for a given purpose so that it will work, but to do this so that it will not cost too much is an entirely different problem. To know what to omit is a rare talent. I once found a young man who could tell students what to store up in their minds for immediate use, and what to skim over or omit; but I could not keep him long, for more lucrative positions are always waiting for such men.

The advice I gave my wealthy friend was given before the Stevens Institute had developed in the direction it has now. The foundation of this advice, namely, to combine a certain amount of judicious practice with theory, is now in a fair way to be carried out, and although things will probably not be permitted to break here, the students will doubtless have opportunities for looking around them and supplementing their systematic instruction here by observation abroad.

LIGHT STEAM ENGINE FOR BALLOONS.

We here illustrate one of a couple of compound engines designed and constructed by Messrs. Ahrbecker, Son & Hamkens, of Stamford Street, S.E., for Captain Mojaisky, of the Russian Imperial Navy, who intends to use them for aeronautical purposes. The larger of these engines has cylinders 3¾ in. and 7½ in. in diameter and 5 in. stroke, and when making 300 revolutions per minute it develops 20 actual horse power, while its weight is but 105 lbs. The smaller engine--the one illustrated--has cylinders 2½ in. and 5 in. in diameter, and 3½ in. stroke, and weighs 63 lbs., while when making 450 revolutions it develops 10 actual horse power.

The two engines are identical in design, and are constructed of forged steel with the exception of the bearings, connecting-rods, crossheads, slide valves and pumps, which are of phosphor-bronze. The cylinders, with the steam passages, etc., are shaped out of the solid. The standards, as will be seen, are of very light T steel, the crankshafts and pins are hollow, as are also the crosshead bolts and piston rods. The small engine drives a single-acting air pump of the ordinary type by a crank, not shown in the drawing. The condenser is formed of a series of hollow gratings.



LIGHT STEAM ENGINE FOR AERONAUTICAL PURPOSES

Steam is supplied to the two engines by one boiler of the Herreshoff steam generator type, with certain modifications, introduced by the designers, to insure the utmost certainty in working. It is of steel, the outside dimensions being 22 in. in diameter, 25 in. high, and weighs 142 lb. The fuel used is petroleum, and the working pressure 190 lb. per square inch.

The constructors consider the power developed by these engines very moderate, on account of the low piston speed specified in this particular case. In some small and light engines by the same makers the piston speed is as high as 1000 ft. per minute. The engines now illustrated form an interesting example of special designing, and Messrs. Ahrbecker, Son, and Hamkens deserve much credit for the manner in which the work has been turned out, the construction of such light engines involving many practical difficulties,--*Engineering.*

Mount Baker, Washington Territory, has shown slight symptoms of volcanic activity for several years. An unmistakable eruption is now in progress.

COMPLETE PREVENTION OF INCRUSTATION IN BOILERS.

The chemical factory, Eisenbuettel, near Braunschweig, distributes the following circular: "The principal generators of incrustation in boilers are gypsum and the so-called bicarbonates of calcium and magnesium. If these can be taken put of the water, before it enters the boiler, the formation of incrustation is made impossible; all disturbances and troubles, derived from these incrustations, are done away with, and besides this, a considerable saving of fuel is possible, as clear iron will conduct heat quicker than that which is covered with incrustation."

J. Kolb, according to *Dingler's Polyt. Journal*, says: "A boiler with clear sides yielded with 1 kil. coal 7.5 kil. steam, after two months only 6.4 kil. steam, or a decrease of 17 per cent. At the same time the boiler had suffered by continual working."

Suppose a boiler free from inside crust would yield a saving of only 5 per cent. in fuel (and this figure is taken very low compared with practical experiments) it would be at the same time a saving of 3c. per cubic meter water. If the cleaning of one cubic meter water therefore costs less than 3c., this alone would be an advantage.

Already, for a long time, efforts have been made to find some means for this purpose, and we have reached good results with lime and chloride of barium, as well as with magnesia preparations. But these preparations have many disadvantages. Corrosion of the boiler-iron and muriatic acid gas have been detected. (Accounts of the Magdeburg Association for boiler management.)

Chloride of calcium, which is formed by using chloride of barium, increases the boiling point considerably, and diminishes the elasticity of steam; while the sulphate of soda, resulting from the use of carbonate of soda, is completely ineffectual against the boiler iron. It increases the boiling point of water less than all other salts, and diminishes likewise the elasticity of steam (Wullner).

In using magnesia preparation, the precipitation is only very slowly and incompletely effected--one part of the magnesia will be covered by the mire and the formed carbonate of magnesia in such a way, that it can no more dissolve in water and have any effect (*Dingler's Polyt. Journal*, 1877-78).

The use of carbonate of soda is also cheaper than all other above mentioned substances.

One milligramme equivalent sulphate of lime, in 1 liter, = 68 grammes sulphate of lime in 1 cubic meter, requiring for decomposition:

120 gr. (86-88 per cent.) chloride of barium of commerce--at $5.00 = 0.6c.

Or, 50 gr. magnesia preparation--at $10.00 = 0.5c.

Or, 55 gr. (96-98 per cent.) carbonate of soda--at $7.50 = 0.41c.

The proportions of cost by using chloride of barium, magnesia preparation, carbonate of soda, will be 6 : 5 : 4.

ARRANGEMENT FOR PURIFYING BOILER-WATER WITH LIME AND CARBONATE OF SODA.

We need for carrying out these manipulations, according to the size of the establishment, one or more reservoirs for precipitating the impurities of the water, and one pure water reservoir, to take up the purified water; from the latter reservoir the boilers are fed. The most practical idea would be to arrange the precipitating reservoir in such manner that the purified water can flow directly into the feeding reservoir.

The water in the precipitating reservoir is heated either by adding boiling water or letting in steam up to 60° C. at least. The precipitating reservoirs (square iron vessels or horizontal cylinders--old boilers) of no more than 4 or 4½ feet, having a faucet 6 inches above the bottom, through which the purified water is drawn off, and another one at the bottom of the vessel, to let the precipitate off and allow of a perfect cleaning. In a factory with six or seven boilers of the usual size, making together 400 square meters heating surface, two precipitating reservoirs, of ten cubic meters each, and one pure water reservoir of ten or fifteen cubic meter capacity, are used.

In twenty-four hours about 240 cubic meters of water are evaporated; we have, therefore, to purify twenty-four precipitating reservoirs at ten cubic meters each day, or ten cubic meters each hour.

It is profitable to surround the reservoirs with inferior conductors of heat, to avoid losses.

The contents of the precipitating reservoirs have to be stirred up very well, and for this purpose we can either arrange a mechanical stirrer or do it by hand, or the best would be a "Korting steam stirring and blowing apparatus." In using the latter we only have to open the valve, whereby in a very short time the air driven through the water stirs this up and mixes it thoroughly with the precipitating ingredients. In a factory where boilers of only 15 to 100 square meters heating surface are, one precipitating reservoir of two to ten cubic meters and one pure water reservoir of three to ten cubic meters capacity are required. For locomobiles, two wooden tubs or barrels are sufficient.

THE PURIFICATION OF THE WATER.

After the required quantity of lime and carbonate of soda which is necessary for a total precipitation has been figured out from the analysis of the water, respectively verified by practical experiments in the laboratory, the heated water in the reservoir is mixed with the lime, in form of thin milk of lime, and stirred up; we have to add so much lime, that slightly reddened litmus paper gives, after ¼ minute's contact with this mixture, an alkaline reaction, i.e., turns blue; now the solution of carbonate of soda is added and again stirred well.

After twenty or thirty minutes (the hotter the water, the quicker the precipitation) the precipitate has settled in large flocks at the bottom, and the clear water is drawn off into the pure water reservoir. The precipitating and settling of the impurities can also take place in cold water; it will require, however, a pretty long time.

In order to avoid the weighing and slaking of the lime, which is necessary for each precipitation, we use an open barrel, in which a known quantity of slaked lime is mixed with three and a half or four times its weight of water, and then diluted to a thin paste, so that one kilogramme slaked lime is diluted to twenty-five liters milk of lime.

Example.--If we use for ten cubic meters water, one kilogramme lime, or in one day (in twenty-four hours), 240 cubic meters 24 kg. lime, a vessel four or five feet high and about 700 liters capacity, in which daily 24 kg. lime with about 100 liters water are slaked and then diluted to the mark 600, constantly stirring, 25 liters of this mixture contain exactly 1 kg. slaked lime.

Before using, this milk of lime has to be stirred up and allowed to settle for a few seconds; and then we draw off the required quantity of milk of lime (in our case 25 liters) through a faucet about 8 inches above the bottom, or we can dip it off with a pail. For the first precipitate we always need the exact amount of milk of lime, which we have figured out, or rather some more, but for the next precipitates we do not want the whole quantity, but always less, as that part of the lime, which does not settle with the precipitate, will be good for use in further precipitations. It is therefore important to control the addition of milk of lime by the use of litmus paper. If we do not add enough lime, it prevents the formation of the flocky precipitate, and, besides, more carbonate of soda is used. By adding too much lime, we also use more carbonate of soda in order to precipitate the excess of lime. We can therefore add so much lime, that there is only a very small excess of hydrous lime in the water, and that after well stirring, a red litmus paper being placed in the water for twenty seconds, appears only slightly blue. After a short time of practice, an attentive person can always get the exact amount of lime which ought to be added. On adding the milk of lime, we have to dissolve the required amount of pure carbonate of soda in an iron kettle, in about six or eight parts hot water with the assistance of steam; add this to the other liquid in the precipitating reservoirs and stir up well. The water will get clear after twenty-five or thirty minutes, and is then drawn off into the pure water reservoir.

EXAMINATION OF WATER WHICH HAS BEEN PURIFIED BY MEANS OF MILK OF LIME AND CARBONATE OF SODA.

In order to be convinced that the purification of the water has been properly conducted, we try the water in the following manner. Take a sample of the purified water into a small tumbler, and add a few drops of a solution of oxalate of ammonia; this addition must neither immediately nor after some minutes cause a milky appearance of the water, but remain bright and clear. A white precipitate would indicate that not enough carbonate of soda had been added. A new sample is taken of the purified water and a solution of chloride of calcium added; a milky appearance, especially after heating, would show that too much carbonate of soda had been added.

RESULTS OF THIS WATER PURIFICATION.

1. The boilers do not need to be cleaned during a whole season, as they remain entirely free from incrustation; it is only required to avoid a collection of soluble salts in the boiler, and therefore it is partly drawn off twice a week.

2. The iron is not touched by this purified water. The water does not froth and does not stop up valves. The fillings in the joints of pipes, etc., do not suffer so much, and therefore keep longer.

3. The steam is entirely free from sour gases.

4. The production of steam is easier and better.

5. A considerable saving of fuel can soon be perceived.

6. The cost of cleaning boilers from incrustation, and loss of time caused by cleaning, is entirely done with. Old incrustations, which could not be cleaned out before, get decomposed and break off in soft pieces.

7. The cost of this purification is covered sufficiently by the above advantages, and besides this, the method is cheaper and surer than any other.

The chemical factory, Eisenbuettel, furnishes pure carbonate of soda in single packages, which exactly correspond with the quantity, stated by the analysis, of ten cubic meters of a certain water. The determination of the quantities of lime and carbonate of soda necessary for a certain kind of water, after sending in a sample, will be done without extra charge.--*Neue Zeitung fur Ruebenzucker Industrie*.

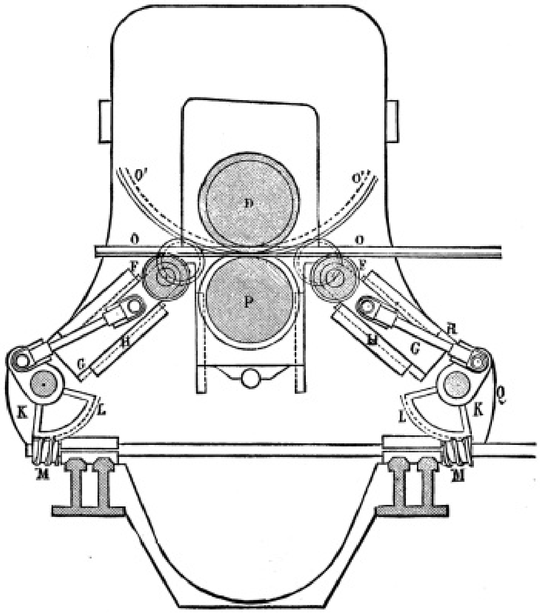
EDDYSTONE LIGHTHOUSE.

The exterior work on the new Eddystone Lighthouse is about two thirds done. In the latter part of April fifty-three courses of granite masonry, rising to the height of seventy feet above high water, had been laid, and thirty-six courses remained to be set. The old lighthouse had been already overtopped. As the work advances toward completion the question arises: What shall be done with John Smeaton's famous tower, which has done such admirable service for 120 years? One proposition is to take it down to the level of the top of the solid portion, and leave the rest as a perpetual memorial of the great work which Smeaton accomplished in the face of obstacles vastly greater than those which confront the modern architect. The London *News* says: "Were Smeaton's beautiful tower to be literally consigned to the waves, we should regard the act as a national calamity, not to say scandal; and, if public funds are not available for its conservation, we trust that private zeal and munificence may be relied on to save from destruction so interesting a relic. It certainly could not cost much to convey the building in sections to the mainland, and there, on some suitable spot, to re-erect it as a national tribute to the genius of its great architect." When the present lighthouse was built one of the chief difficulties was in getting the building materials to the spot. They were conveyed from Millbay in small sailing vessels, which often beat about for days before they could effect a landing at the Eddystone rocks, so that each arrival called out the special gratitude of Smeaton.

ROLLING-MILL FOR MAKING CORRUGATED IRON.

MESSRS. SCHULZ, KNAUDT & Co., of Essen, who are making an application of corrugated iron in the construction of the interior flues of steam boilers, have devised a new mill for the manufacture of this form of iron plates, and which is represented in the accompanying cut, taken from the *Deutsche Industrie Zeitung*. The supports of the two accessory cylinders, F F, rest on two slides, G G, which move along the oblique guides, H H. As a consequence of this arrangement, when the cylinders, F F, are caused to approach the cylinder, D, both are raised at the same instant.

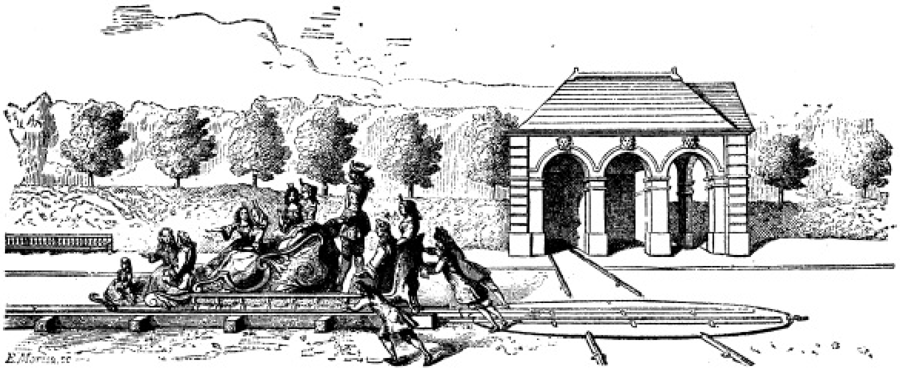
When the cylinders, F, occupy the position represented in the engraving by unbroken lines, the flat plate, O, is simply submitted to pressure between the cylinders, D and P, the cylinders, F F, then merely acting as guides. But when, while the plate is being thus flattened between the principal cylinders, the accessory cylinders are caused to rise, the plate is curved as shown by the dotted lines, O' O'. To obtain a uniformity in the position of the two cylinders, F F, the following mechanism is employed: Each cylinder has an axle, to which is affixed a crank, Q, connected by means of a rod, R, with the slide, G. These axles are also provided with toothed sectors, L L, which gear with two screws, L L, whose threads run in opposite directions. These screws are mounted on a shaft, N, which may be revolved by any suitable arrangement.



ROLLING MILL FOR MAKING CORRUGATED IRON

RAILWAY TURN-TABLE IN THE TIME OF LOUIS XIV.

The small engraving which we reproduce herewith from *La Nature* is deposited at the Archives at Paris. It is catalogued in the documents relating to Old Marly, 1714, under number 11,339, Vol. 1. The design represents a diversion called the *Jeu de la Roulette* which was indulged in by the royal family at the sumptuous and magnificent chateau of Mary-le-Roi.



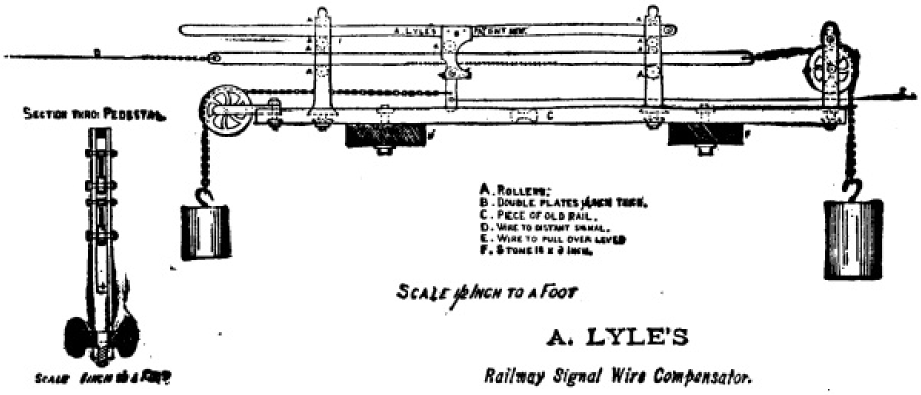
PLEASURE CAR; RAILWAY AND TURN-TABLE OF THE TIME OF LOUIS XIV.

According to Alex. Guillaumot the apparatus consisted of a sort of railway on which the car was moved by manual labor. In the car, which was decorated with the royal colors, are seen seated the ladies and children of the king's household, while the king himself stands in the rear and seems to be directing operations. The remarkable peculiarity to which we would direct the attention of the reader is that this document shows that the car ran on rails very nearly like those used on the railways of the present time, and that a turn-table served for changing the direction to a right angle in order to place the car under the shelter of a small building. The picture which we reproduce, and the authenticity of which is certain, proves then that in the time of Louis XIV. our present railway turn-tables had been thought of and constructed--which is a historic fact worthy of being noted. It is well known that the use of railways in mines is of very ancient date, but we do not believe that there are on record any documents as precise as that of the *Jeu de la Roulette* as to the existence of turn-tables in former ages.

NEW SIGNAL WIRE COMPENSATOR.

To the Editor of the Scientific American:

I send you a plate of my new railway signal wire compensator. Here in India signal wires give more trouble, perhaps, than in America or elsewhere, by expansion and contraction. What makes the difficulty more here is the ignorance and indolence of the point and signalmen, who are all natives. There have been numerous collisions, owing to signals falling off by contraction. Many devices and systems have been tried, but none have given the desired result. You will observe the signal wire marked D is entirely separated and independent of the wire, E, leading to lever. On the Great Indian and Peninsula Railway I work one of these compensators, 1,160 yards from signal, which stands on a summit the grade of which is 1 in 150; and on the Nizam State Railway I have one working on a signal 800 yards. This signal had previously given so much trouble that it was decided to do away with it altogether. It stands on top of a high cutting and on a 1,600 foot curve.



Railway Signal Wire Comensator

I have noted on the compensator fixed at 1,160 yards, 13¼ inches contraction and expansion. The compensator is very simple and not at all likely to get out of order. On new wire, when I fix my compensator, I usually have an adjusting screw on the lead to lever. This I remove when the wire has been stretched to its full tension. I have everything removed from lever, so there can be no meddling or altering. When once the wire is stretched so that no slack remains between lever and trigger, no further adjustment is necessary.

A. LYLE,

Chief Maintenance Inspector, Permanent Way,

H.H. Nizam State Railway, E. India.

Secunderabad, India, 1881.

TANGYE'S HYDRAULIC HOIST.

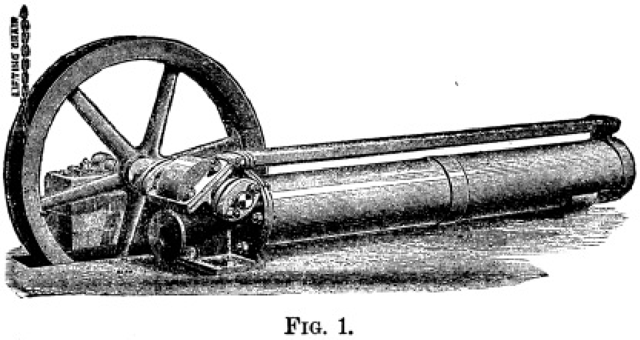


FIG. 1.

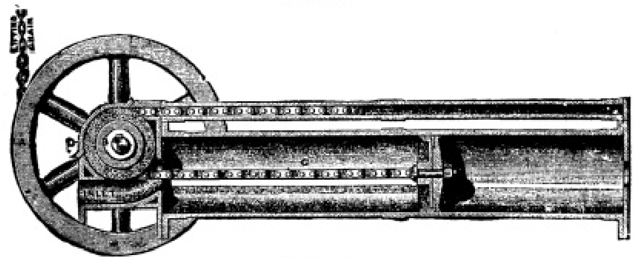


FIG. 2.

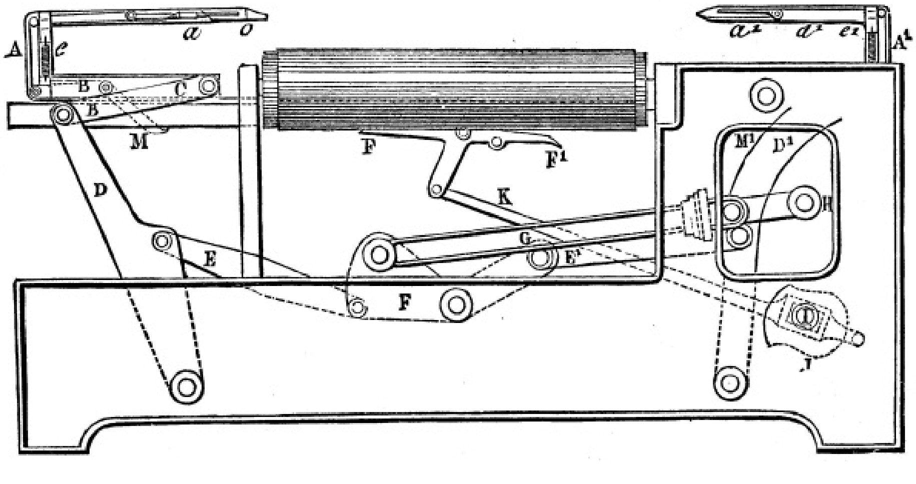
TANGYE'S HYDRAULIC HOIST.

The great merits of hydraulic hoists generally as regards safety and readiness of control are too well known to need pointing out here. We may, therefore, at once proceed to introduce to our readers the apparatus of this class illustrated in the above engravings. This is a hoist (Cherry's patent) manufactured by Messrs. Tangye Brothers, of London and Birmingham, and which experience has proved to be a most useful adjunct in warehouses, railway stations, hotels, and the like. Fig. 1 of our engraving shows a perspective view of the hoist, Fig. 2 being a longitudinal section.

It will be seen that this apparatus is of very simple construction, the motion of the piston being transmitted directly to the winding-drum shaft by means of a flexible steel rack. Referring to Fig. 2, F is a piston working in the cylinder, G; E is the flexible steel rack connected to the piston, F, and gearing with a toothed wheel, B, which is inclosed in a watertight casing having cover, D, for convenient access. The wheel, B, is keyed on a steel shaft, C, which passes through stuffing-boxes in the casing, and has the winding barrel, A, keyed on it outside the casing. H is a rectangular tube, which guides the free end of the flexible steel rack, E. The hoist is fitted with a stopping and starting valve, by means of which water under pressure from any convenient source of supply may be admitted or exhausted from the cylinder. The action in lifting is as follows: The water pressure forces the piston toward the end of the cylinder. The piston, by means of the flexible steel rack, causes the toothed wheel to revolve. The winding barrel, being keyed on the same shaft as the toothed wheel, also revolves, and winds up the weight by means of the lifting chain. Two special advantages are obtained by this simple method of construction. In the first place, twice the length of stroke can be obtained in the same space as compared with the older types of hydraulic hoist; and, from the directness of the action, the friction is reduced to a minimum. This simple method of construction renders the hoist very compact and easily fixed; and, from the directness with which the power is conveyed from the piston to the winding drum, and the frictionless nature of the mechanism, a smaller piston suffices than in the ordinary hydraulic hoists, and a smaller quantity of water is required to work them.--*Iron*.

POWER LOOM FOR DELICATE FABRICS.

The force with which the shuttle is thrown in an ordinary power loom moving with a certain speed is always considerable, and, as a consequence of the strain exerted on the thread, it is frequently necessary to use a woof stronger than is desirable, in order that it may have sufficient resistance. On another hand, when the woof must be very fine and delicate the fabric is often advantageously woven on a hand loom. In order to facilitate the manufacture of like tissues on the power loom the celebrated Swiss manufacturer, Hanneger, has invented an apparatus in which the shuttle is not thrown, but passed from one side to the other by means of hooks, by a process analogous to weaving silk by hand. A loom built on this principle was shown at work weaving silk at the Paris Exhibition of 1878. This apparatus, represented in the annexed figure, contains some arrangements which are new and interesting. On each side of the woof in the heddle there is a carrier, B. These carriers are provided with hooks, A A', having appendages, *a a'*, which are fitted in the shuttle, O. The latter is of peculiar construction. The upper ends of the hooks have fingers, *d d'*, which holds the shuttle in position as long as the action of the springs, *e e'*, continues. The distance that the shuttle has to travel includes the breadth of the heddle, the length of the shuttle, and about four inches in addition. The motion of the two carriers, which approach each other and recede simultaneously, is effected by the levers, C, D, E, and C', D', E'. The levers, E, E', are actuated by a piece, F, which receives its motion from the main shaft, H, through the intervention of a crank and a connecting rod, G, and makes a little more than a quarter revolution. The levers, E, E', are articulated in such a way that the motion transmitted by them is slackened toward the outer end and quickened toward the middle of the loom. While the carriers, B B', are receiving their alternate backward and forward motion, the shaft, I (which revolves only half as fast as the main shaft), causes a lever, F F', to swing, through the aid of a crank, J, and rod, K. Upon the two carriers, B B', are firmly attached two hooks, M M', which move with them. When the hook, M, approaches the extremity of the lever, F, the latter raises it, pushes against the spring, E, and sets free the shuttle, which, at the same moment, meets the opposite hook, *a'*, and, being caught by it, is carried over to the other side. The same thing happens when the carrier, B', is on its return travel, and the hook, M', mounts the lever, F', which is then raised.



As will be seen from this description, the woof does not undergo the least strain, and may be drawn very gently from the shuttle. Neither does this latter exert any friction on the chain, since it does not move on it as in ordinary looms. In this apparatus, therefore, there may be employed for the chain very delicate threads, which, in other looms, would be injured by the shuttle passing over them. Looms constructed on this plan have for some time been in very successful use in Switzerland.

HOW VENEERING IS MADE.

The process of manufacture is very interesting. The logs are delivered in the mill yard in any suitable lengths as for ordinary lumber. A steam drag saw cuts them into such lengths as may be required by the order in hand; those being cut at the time of our visit were four feet long. After cutting, the logs are placed in a large steam box, 15 feet wide, 22 feet long, and six feet high, built separate from the main building. This box is divided into two compartments. When one is filled entirely full, the doors are closed, and the steam, supplied by the engine in the main building, is turned on. The logs remain in this box from three to four hours, when they are ready for use. This steaming not only removes the bark, but moistens and softens the entire log. From the steam box the log goes to the veneer lathe. It is here raised, grasped at each end by the lathe centers, and firmly held in position, beginning to slowly revolve. Every turn brings it in contact with the knife, which is gauged to a required thickness. As the log revolves the inequalities of its surface of course first come in contact with the keen-edged knife, and disappear in the shape of waste veneer, which is passed to the engine room to be used as fuel. Soon, however, the unevenness of the log disappears, and the now perfect veneer comes from beneath the knife in a continuous sheet, and is received and passed on to the cutting table. This continues until the log is reduced to about a seven inch core, which is useless for the purpose. The veneer as it comes rolling off the log presents all the diversity of colors and the beautiful grain and rich marking that have perhaps for centuries been growing to perfection in the silent depths of our great forests.

From the lathe, the veneer is passed to the cutting table, where it is cut to lengths and widths as desired. It is then conveyed to the second story, where it is placed in large dry rooms, air tight, except as the air reaches them through the proper channels. The veneer is here placed in crates, each piece separate and standing on edge. The hot air is then turned on. This comes from the sheet iron furnace attached to the boiler in the engine room below, and is conveyed through large pipes regulated by dampers for putting on or taking off the heat. There is also a blower attached which keeps the hot air in the dry rooms in constant motion, the air as it cools passing off through an escape pipe in the roof, while the freshly heated air takes its place from below. These rooms are also provided with a net-work of hot air pipes near the floor. The temperature is kept at about 165°, and so rapid is the drying process that in the short space of four hours the green log from the steam box is shaved, cut, dried, packed, and ready for shipment.

After leaving the dry rooms it is assorted, counted, and put up in packages of one hundred each, and tied with cords like lath, when it is ready for shipment. Bird's-eye maple veneer is much more valuable and requires more care than almost any other, and this is packed in cases instead of tied in bundles. The drying process is usually a slow one, and conducted in open sheds simply exposed to the air. Mr. Densmore's invention will revolutionize this process, and already gives his mill a most decided advantage.

The mill will cut about 30,000 feet of veneer in a day, and this cut can be increased to 40,000 if necessary. Mr. Densmore has already received several large orders, and the rapidly increasing demand for this material is likely to give the mill all the work it can do. The timber used is principally curled and bird's-eye maple, beech, birch, cherry, ash, and oak. These all grow in abundance in this vicinity, and the beautifully marked and grained timber of our forests will find fitting places in the ornamental uses these veneers will be put to.

THE CONSTITUENT PARTS OF LEATHER.

The constituent parts of leather seem to be but little understood. The opinions of those engaged in the manufacture of leather differ widely on this question.

Some think that tannin assimilates itself with the hide and becomes fixed there by reason of a special affinity. Others regard the hide as a chemical combination of gelatine and tannin. We know that the hide contains some matters which are not ineradicable, but only need a slight washing to detach them.

We deem it advisable, in order to examine the hide properly so-called, to dispense with those eradicable substances which may be regarded, to some extent, as not germain to it, and confine our attention to the raw stock, freed from these imperfections.

It is well known that a large number of vegetable substances are employed as tanning agents. Our researches have been directed to leather tanned by means of the most important of these agents.

Many questions present themselves in the course of such an examination. Among others, that most important one, from a practical point of view, of the weight the tanning agent gives to the hide, that is to say, the result in leather of weight given to the raw material. The degree of tannage is also to be considered; the length of time during which the tanning agent is to be left with the hide; in short, the influence upon the leather of the substances used in its production. That is why we have made the completest possible analysis of different leathers.

Besides ordinary oak bark there are used at present very different substances, such as laurel, chestnut, hemlock, quebracho and pine bark, sumac, etc.

Water is an element that exists in all hides, and it is necessary to take it into consideration in the analysis. It is present in perceptible quantity even in dry hides. This water cannot be entirely eradicated without injuring the leather, which will lose in suppleness and appearance. Water should then be considered as one of the elements of leather, but it must be understood that if it exceeds certain limits, say 12 to 14 per cent., it becomes useless and even injurious. Moreover, if there is any excess over the normal quantity, it becomes deceptive and dishonest, as in such a case one sells for hides that which is nothing but water. Supposing that a hide, instead of only 14 per cent., contained 18 per cent. of water, it is evident that in buying 100 pounds of such a hide one would pay for four pounds of water at the rate for which he purchased the hide.

There are, also, some matters soluble in air, which are formed to a large extent from fat arising as much from the hide as from tanning substances. The air dissolves at the same time a certain amount of organic acid and resinous products which the hide has absorbed. After treating with air, alcohol is used, which dissolves principally the coloring matters, tannin which has not become assimilated, bodies analogous to resin, and some extractive substances.

That which remains after these methods have been pursued ought to be regarded as the hide proper, that is to say, as the animal tissue saturated with tannic acid. In this remainder one is able to estimate with close precision that which belongs to the hide. The hide being an elementary tissue of unchangeable form, it is easy, in determining the elementary portion, to find the amount of real hide remaining in the product. With these elements one can arrive at a solution of some of the questions we are discussing.

We give below, according to this method, a table showing the composition of the different leathers exhibited at the Paris Exposition of 1878. They are the results of careful research, and we have based our work upon them:

	Moisture	Matter Soluble in Air	Matter Soluble in Alcohol	Gelatine	Fixed Tannin
Steer hide, hemlock tanned (heavy leather)	10.95	4.15	19.77	39.1	26.03
Sheepskins, sumac " (Hungarian)	10.8	10.3	12.1	40.3	26.5
Finished calf, pine bark tanned (Hungarian)	11.2	1.7	7.4	41.6	38.1
Steer hide, quebracho tanned (heavy leather)	11.7	1.6	11.2	43.1	32.4
" " chestnut " " "	13.5	0.29	1.99	45.46	38.76
Finished calfskins, oak tanned (Chateau Renault)	12.4	0.33	3.59	46.74	36.94
Steer hide, laurel tanned (heavy leather)	12.4	1.05	7.95	47.47	31.13
" " oak tanned after three years in the vats (heavy leather)	11.45	0.37	3.31	49.85	35.02

The following table shows the amount of leather produced by different tannages of 100 pounds of hides:

	Pounds.
Hemlock	255.7
Sumac	248.1
Pine	240.3
Quebracho	232
Chestnut	219.9

Oak	213.9
Laurel	210.6
Oak, lasting three years	206

It is important to mention here the large proportion of resinous matter hemlock-tanned leather contains. This resin is a very beautiful red substance, which communicates its peculiar color to the leather.

We should mention here that in these calculations we assume that the hide is in a perfectly dry state, water being a changeable element which does not allow one to arrive at a precise result.

These figures show the enormous differences resulting from diverse methods of tanning. Hemlock, which threatens to flood the markets of Europe, distinguishes itself above all. The high results attributable to the large proportion of resin that the hide assimilates, explain in part the lowness of its price, which renders it so formidable a competitor. One is also surprised at the large return from sumac-tanned hides when it is remembered in how short a time the tanning was accomplished, which, in the present case, only occupied half an hour.

The figures show us that the greatest return is obtained by means of those tanning substances which are richest in resin. In short, hemlock, sumac, and pine, which give the greatest return, are those containing the largest amount of resin. Thus, hemlock bark gives 10.58 per cent. of it, and sumac leaves 22.7 per cent., besides the tannin which they contain. We know also that pine bark is very rich in resin. There is, then, advantage to the tanner, so far as the question of result is concerned, in using these materials. There is, however, another side to the question, as the leather thus surcharged with resin is of inferior quality, generally has a lower commercial value, and is often of a color but little esteemed.

The percentage of tannin absorbed by the different methods of tannages appears in the following table:

Hemlock	64.2
Sumac	61.4
Pine	90.8
Quebracho	75.3
Chestnut	85.2
Oak	76.9
Laurel	64.8
Oak, three years in the vat	70.2

The subjoined is a statement of the gelatine and tannin in leather of different tannages, and also shows the amount of azote or elementary matter contained in each:

	Gelatine.	Tannin.	Azote.
Hemlock	60.4	39.6	10.88
Sumac	60.4	39.6	11
Pine bark	52.5	47.5	9.56
Quebracho	57.1	42.9	10.4
Chestnut	53.97	46.03	9.79
Oak	55.87	44.13	10.24
Laurel	60.4	39.6	10.94
Oak, 3 years in vat	58.75	41.25	10.65

It is not pretended that these figures are absolutely correct, as they often vary in certain limits even for similar products. They form, however, a fair basis of calculation.

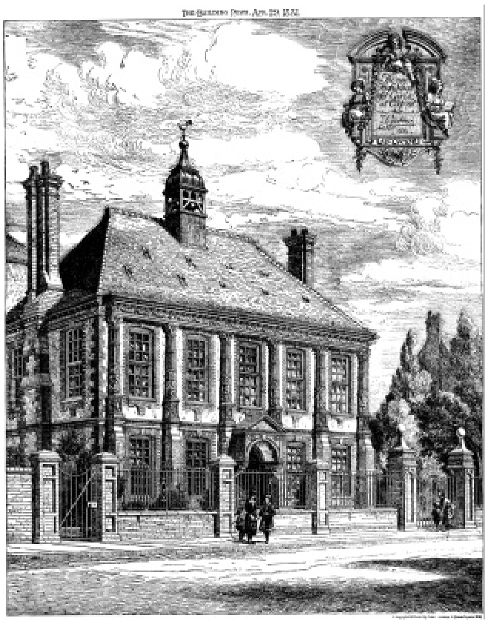
As to whether leather is a veritable combination, it seems to us that this question should be answered affirmatively. In fact, the resistance of leather properly so-called to neutral dissolvents, argues in favor of this opinion.

Furthermore, the perceptible proportion of tannin remaining absorbed by a like amount of hide is another powerful argument. It remains for us to say here that the differences observable in the quantity of fixed tannin ought to arise chiefly from the different natures of these tannins, which have properties differing as do those of one plant from another, and which really have but one property in common, that of assimilating themselves with animal tissues and rendering them imputrescible.

In conclusion, these researches determine the functions of resinous matters which frequently accompany tannin; they show a very simple method for estimating the results of one's work, as well as the degree of tannage.--*Muntz & Schoen, in La Halle aux Cuirs*.--*Shoe & Leather Reporter*.

NEW HIGH SCHOOL FOR GIRLS, OXFORD.

The new High School for Girls at Oxford, built by Mr. T.G. Jackson, for the Girls' Public Day School Company, Limited, was opened September 23, 1880, when the school was transferred from the temporary premises it had occupied in St. Giles's. The new building stands in St. Giles's road, East, to the north of Oxford, on land leased from University College, and contains accommodation for about 270 pupils in 11 class-rooms, some of which communicate by sliding doors, besides a residence for the mistress, an office and waiting-room, a room for the teachers, cloak rooms, kitchens, and other necessary offices, and a large hall, 50 ft. by 30 ft., for the general assembling of the school together and for use on speech-days and other public occasions. The principal front faces St. Giles's road, and is shown in the accompanying illustration. The great hall occupies the whole of the upper story of the front building, with the office and cloak-rooms below it, and the principal entrance in the center. The class-rooms are all placed in the rear of the building, to secure quiet, and open on each floor into a corridor surrounding the main staircase which occupies the center of the building. The walls are built of Headington stone in rubble work, with dressings of brick, between which the walling is plastered, and the front is enriched with cornices and pilasters, and a hood over the entrance door, all of terra cotta. The hinder part of the building is kept studiously simple and plain on account of expense. Behind the school is a large playground, which is provided with an asphalt tennis-court, and is picturesquely shaded with apple-trees, the survivors of an old orchard. The builders were Messrs. Symm & Co., of Oxford; and the terra cotta was made by Messrs. Doulton, of Lambeth. Mr. E. Long was clerk of works.--*Building News*.



SUGGESTIONS IN ARCHITECTURE--NEW HIGH SCHOOL, OXFORD

PROGRESS IN AMERICAN POTTERY.

No advance in any industry has been more sure than in that of pottery and chinaware, under the American tariff, or more rapid in the past four or five years. It took Europe three centuries and the jealous precautions of royal pottery proprietors to build up the great protectorates that made their distinctive trade-marks of such value. The earlier lusters of the Italian faience were guild privacies or individual secrets, as was almost all the craft of the earlier art-worker. Royal patronage in England was equivalent to a protective tariff for Josiah Wedgwood; and everywhere the importance of guarding the china nurseries has been understood. We have in this country broadcast and in abundance every type of material needed for the finest china ware, and for the finer glasses and enamels. The royal manufactories in Europe were hard put to it sometimes for want of discovering kaolin beds in their dominions, but the resources of the United States in these particulars needed something more than to be brought to light. The manipulation and washing of the clays to render them immediately useful to the potteries depends entirely upon the reliance of these establishments upon home materials. The Missouri potteries have their supplies near home, but these supplies must be put upon the market for other cities in condition to compete with the clays of Europe. There are fine kaolin beds in Chester and Delaware counties in this State; there are clay beds in New Jersey, and the recent needs of Ohio potteries have uncovered fine clay in that State. This shows that not only for the manufacture itself, but for the development of material here, everything depends upon the stimulus that protection gives.

Ohio china and Cincinnati pottery are known all over the country. The Chelsea

Works, near Boston, however, are as distinguished for their clays and faience, and for lustrous tiles especially (to be used in household decoration) can rival the rich show that the Doulton ware made at the Centennial. Other New England potteries are eminent for terra cotta and granite wares. On Long Island and in New York city there are porcelain and terra cotta factories of established fame, and the first porcelain work to succeed in home markets was made at the still busy factories of Greenpoint. New Jersey potteries take the broad ground of the useful, first of all, in their manufacture of excellent granite and cream-colored ware for domestic use, but every year turn out more beautiful forms and more artistic work. The Etruria Company especially have succeeded in giving the warm flesh tints to the "Parian" for busts and statuettes, now to be seen in many shop windows. These goods ought always to be labeled and known as American--it adds to their value with any true connoisseur. Some of these establishments, more than others, have the enterprise to experiment in native clays, for which the whole trade owes their acknowledgments.

The demand all through the country by skillful decorators for the pottery forms to work upon, points to still greater extensions in this business of making our own china, and to the employment and good pay of more thousands than are now employed in it. A collection of American china, terra cotta, etc., begun at this time and added to from year to year, will soon be a most interesting cabinet. Both in the eastern and western manufactories ingenious workers are rediscovering and experimenting in pastes and glazes and colors, simply because there is a large demand for all such, and they can be supplied at prices within the reach of most buyers. It needs only to point out this flourishing state of things, through the "let-alone" principle, which protection insures to this industry, to exhibit the threatened damage of the attempt, under cover of earthenware duties, to get a little free trade through at this session.--*Philadelphia Public Ledger*.

PHOTOGRAPHIC NOTES.

Mr. Warnerke's New Discovery.--Very happily for our art, we are at the present moment entering upon a stage of improvement which shows that photography is advancing with vast strides toward a position that has the possibility of a marvelous future. In England, especially, great advances are being made. The recent experiments of our accomplished colleague, Mr. Warnerke, on gelatine rendered insoluble by light, after it has been sensitized by silver bromide and developed by pyrogallic acid, have revealed to us a number of new facts whose valuable results it is impossible at present to foretell. It seems, however, certain that we shall thus be able to accomplish very nearly the same effects as those obtained by bichromatized gelatine, but with the additional advantage of a much greater rapidity in all the operations. In my own experiments with the new process of phototypie, I hit upon the plan of plunging the carbon image, from which all soluble gelatine had been removed, into a bath of pyrogallic acid, in order to still further render impermeable the substance forming the printing surface. I also conceived the idea of afterward saturating this carbon image with a solution of nitrate of silver, and of subsequently treating it with pyrogallic acid, in order to still further render impermeable the substance forming the printing surface. But the process described by Mr. Warnerke is quite different; by means of it we shall be able to fix the image taken in the camera, in the same way as we develop carbon pictures, and afterward to employ them in any manner that may be desirable. Thus the positive process of carbon printing would be modified in such a manner that the mixtures containing the permanent pigment should be sensitized with silver bromide in place of potassium bichromate. In this way impressions could be very rapidly taken of positive proofs, and enlargements made, which might be developed in hot water, just as in the ordinary carbon process, and at least we should have permanent images. Mr. Warnerke's highly interesting experiments will no doubt open the way to many valuable applications, and will realize a marked progress in the art of photography.

Method for Converting Negatives Directly into Positives.--Captain Bing, who is employed in the topographic studios of the Ministry of War, has devised a process for the direct conversion of negatives into positives. The idea is not a new one; but several experimenters, and notably the late Thomas Sutton, have pointed out the means of effecting this conversion; it has never, however, so far as I know, been introduced into actual practice, as is now the case. The process which I am about to describe is now worked in the studios of the Topographic Service. The negative image is developed in the ordinary way, but the development is carried much further than if it were to be used as an ordinary negative. After developing and thoroughly washing, the negative is placed on a black cloth with the collodion side downward, and exposed to diffuse light for a time, which varies from a few seconds to two or three minutes, according to the intensity of the plate. Afterward the conversion is effected by moistening the plate afresh, and then plunging it into a bath which is thus composed:

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Water                   700 cub. cents.
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Potassium bichromate	30 grams.
Pure nitric acid	300 cub. cents.

In a few minutes this solution will dissolve all the reduced silver forming the negative; the negative image is therefore entirely destroyed; but it has served to impress on the sensitive film beneath it a positive image, which is still in a latent condition. It must, therefore, be developed, and to do this, the film is treated with a solution of--

Water	1,000 grams
Pyrogallic acid	25 "
Citric acid	20 "
Alcohol of 36°	50 cub. cents.

The process is carried on exactly as if developing an ordinary negative; but the action of the developer is stopped at the precise moment when the positive has acquired intensity sufficient for the purpose for which it is to be used. Fixing, varnishing, etc., are then carried on the usual way. The great advantage of this process consists in the fact of its rendering positives of much greater delicacy than those that are taken by contact; and, on the other hand, by means of it we are able to avoid two distinct operations, when for certain kinds of work we require positive plates where a negative would be of no service. M. V. Rau, the assistant who has carried out this process under the direction of Captain Bing, has described it in a work which has just been published by M. Gauthier-Villars.

Experiments of Captain Bing on the Sensitiveness of Coal Oil.--The same Captain of Engineers has undertaken a series of very interesting experiments on the sensitiveness to light of one or two substances to which bitumen probably owes its sensitiveness, but which, contrary to what takes place with bitumen, are capable of rendering very beautiful half tones, both on polished zinc and on albumenized paper. These sensitive substances are extracted by dissolving marine glue or coal-tar in benzine. By exposure to light, both marine-glue and coal-tar turn of a sepia color, and, in a printing-frame, they render a visible image, which is not the case with bitumen; their solvents are in the order of their energy; chloroform, ether, benzine, turpentine, petroleum spirit, and alcohol. Of these solvents, benzine is the best adapted for reducing the substances to a fluid state, so as to enable them to flow over the zinc. The images obtained, which are permanent, and which are very much like those of the Daguerreotype, are fixed by means of the turpentine and petroleum spirit. They are washed with water, and then carefully dried. It is possible to obtain prints with half-tones in fatty ink by means of plates of zinc coated with marine-glue. Some attempts in this direction were shown to me, which promised very well in this respect. We are, therefore, in the right road, not only for economically producing permanent prints on paper, but also for making zinc plates in which the phototype film of bichromatized gelatine is replaced by a solution of marine-glue and benzine. The substance known in commerce under the name of pitch or coal-tar will produce the same results.

Bitumen Plates.--A new method of making bitumen plates by contact has also been introduced into the topographical studios. The plan, or the original drawing, is placed against a glass plate, coated with a mixture of bitumen and of marine-glue dissolved in benzine. The marine-glue gives the bitumen greater pliancy, and prevents it from scaling off when rubbed, particularly when the plate is retouched with a dry point. These bitumen plates are so thoroughly opaque to the penetration of the actinic rays, that the printing-frame may be left for any time in full sunlight without any fear of fog being produced on the zinc plate from which the prints are to be taken.

Method for Topographic Engraving by Commandant de la Noë.--Before leaving the interesting studios of which I have been speaking, I ought to mention a very ingenious application which has been made of a process called *topogravure*, invented by Commandant de la Noë, who is the director of this important department. A plate of polished zinc is coated with bitumen in the usual way, and then exposed directly to the light under an original drawing, or even under a printed plan. So soon as the light has sufficiently acted, which may be seen by means of photometric bands equally transparent at the plate, all the bitumen not acted upon is dissolved. As it is a positive which has acted as matrix, the uncovered zinc indicates the design, and the ground remains coated with insoluble bitumen. The plate is then etched with a weak solution of nitric acid in water, and the lines of the design are thus slightly engraved; the surface is then re-coated with another layer of bitumen, which fills up all the hollows, and is then rubbed down with charcoal. All the surface is thus cleaned off, and the only bitumen which remains is that in the lines, which, though not deep, are sufficiently so to protect the substance from the rubbing of the charcoal. When this is done we have an engraved plate which can be printed from, like a lithographic stone; it is gummed and wetted in the usual way, and it gives prints of much greater delicacy and purity than those taken directly from the bitumen. The ink is retained by the slight projection of the surface beyond the line, so that it cannot spread, and a kind of copper plate engraving is taken by lithographic printing. Besides, in arriving at this result, there is the advantage of being able to use directly the original plans and drawings, without being obliged to have recourse to a plate taken in the camera; the latter is indispensable for printing in the usual way on bitumen where the impression on the sensitive film is obtained by means of a negative. It will be seen that this process is exceedingly ingenious, and not only is its application very easy, but all its details are essentially practical.

Succinate of Iron Developer.--I have received a letter from M. Borlinetto, in which he states that he has been induced by the analogy which exists between oxalic and succinic acids to try whether succinate of iron can be substituted for oxalate of iron as a developer. To prove this he prepared some proto-succinate of iron from the succinate of potassium and proto-sulphate of iron, following the method given by Dr. Eder for the preparation of his ferrous oxalate developer. He carried out the development in the same way as is done by the oxalate, and he found that the succinate of iron is even more energetic than the oxalate. The plate develops regularly with much delicacy, and gives a peculiar tone. It is necessary to take some fresh solution at every operation, on account of the proto-succinate of iron being rapidly converted into per-succinate by contact with the air.

Method of Making Friable Hydro-Cellulose.--At the meeting of the Photographic Society of France, M. Girard showed his method of preparing cellulose in a state of powder, specially adapted for the production of pyroxyline for making collodion. Carded cotton-wool is placed in water, acidulated with 3 per cent. of sulphuric or nitric acid, and is left there from five to fifteen seconds; it is then taken out and laid on a linen cloth, which is then wrung so as to extract most of the liquid. In this condition there still remains from 30 to 40 per cent. of acidulated water; the cotton is divided into parcels and allowed to dry in the open air until it feels dry to the touch, though in this condition it still contains 20 per cent. of water. It is next inclosed in a covered jar, which is heated to a temperature of 65° C.; the desiccation therefore takes place in the closed space, and the conversion of the material is completed in about two or three hours. In this way a very perfect hydro-cellulose is obtained, and in the best form for producing excellent pyroxyline.--*Corresp. Photo Mews*.

PHOTO TRACINGS IN BLACK AND COLOR.

Two new processes for taking photo tracings in black and color have recently been published--"Nigrography" and "Anthrakotype"--both of which represent a real advance in photographic art. By these two processes we are enabled for the first time to accomplish the rapid production of positive copies in black of plans and other line drawings. Each of these new methods has its own sphere of action; both, therefore, should deserve equally descriptive notices.

For large plans, drawn with lines of even breadth, and showing no gradated lines, or such as shade into gray, the process styled "nigrography," invented by Itterbeim, of Vienna, and patented both in Germany and Austria, will be found best adapted. The base of this process is a solution of gum, with which large sheets of paper can be more readily coated than with one of gelatine; it is, therefore, very suitable for the preparation of tracings of the largest size. The paper used must be the best drawing paper, thoroughly sized, and on this the solution, consisting of 25 parts of gum arabic dissolved in 100 parts of water, to which are added 7 parts of potassium bichromate and I part of alcohol, is spread with a broad, flat brush. It is then dried, and if placed in a cool, dark place will keep good for a long time. When used, it is placed under the plan to be reproduced, and exposed to diffused light for from five to ten minutes--that is to say, to about 14° of Vogel's photometer; it is then removed and placed for twenty minutes in cold water, in order to wash out all the chromated gum which has not been affected by light. By pressing between two sheets of blotting-paper the water is then got rid of, and if the exposure has been correctly judged the drawing will appear as dull lines on a shiny ground. After the paper has been completely dried it is ready for the black color. This consists of 5 parts of shellac, 100 parts of alcohol, and 15 parts of finely-powdered vine-black. A sponge is used to distribute the color over the paper, and the latter is then laid in a 2 to 3 per cent. bath of sulphuric acid, where it must remain until the black color can be easily removed by means of a stiff brush. All the lines of the drawing will then appear in black on a white ground. These nigrographic tracings are very fine, but they only appear in complete perfection when the original drawings are perfectly opaque. Half-tone lines, or the marks of a red pencil on the original, are not reproduced in the nigrographic copy.

"Anthrakotype" is a kind of dusting-on process. It was invented by Dr. Sobacchi, in the year 1879, and has been lately more fully described by Captain Pizzighelli. This process--called also "Photanthrakography"--is founded on the property of chromated gelatine which has not been acted on by light to swell up in lukewarm water, and to become tacky, so that in this condition it can retain powdered color which had been dusted on it. Wherever, however, the chromated gelatine has been acted on by light, the surface becomes horny, undergoes no change in warm water, and loses all sign of tackiness. In this process absolute opacity in the lines of the original drawing is by no means necessary, for it reproduces gray, half-tone lines just as well as it does black ones. Pencil drawings can also be copied, and in this lies one great advantage of the process over other photo-tracing methods, for, to a certain extent, even half-tones can be produced.

For the paper for anthrakotype an ordinary strong, well-sized paper must be selected. This must be coated with a gelatine solution (gelatine 1, water 30 parts), either by floating the paper on the solution, or by flowing the solution over the paper. In the latter case the paper is softened by soaking in water, is then pressed on to a glass plate placed in a horizontal position, the edges are turned up, and the gelatine solution is poured into the trough thus formed. To sensitize the paper, it is dipped for a couple of minutes in a solution of potassium bichromate (1 in 25), then taken out and dried in the dark.

The paper is now placed beneath the drawing in a copying-frame, and exposed for several minutes to the light; it is afterward laid in cold water in order to remove all excess of chromate. A copy of the original drawing now exists in relief on the swollen gelatine, and, in order to make this relief sticky, the paper is next dipped for a short time in water, at a temperature of about 28° or 30° C. It is then laid on a smooth glass plate, superficially dried by means of blotting-paper, and lamp-black or soot evenly dusted on over the whole surface by means of a fine sieve. Although lamp-black is so inexpensive and so easily obtained, as material it answers the present purpose better than any other black coloring substance. If now the color be evenly distributed with a broad brush, the whole surface of the paper will appear to be thoroughly black. In order to fix the color on the tacky parts of the gelatine, the paper must next be dried by artificial heat--say, by placing it near a stove--and this has the advantage of still further increasing the stickiness of the gelatine in the parts which have not been acted upon by light, so that the coloring matter adheres even more firmly to the gelatine. When the paper is thoroughly dry, place it in water, and let it be played on by a strong jet; this removes all the color from the parts which have been exposed to the light, and so develops the picture. By a little gentle friction with a wet sponge, the development will be materially promoted.

A highly interesting peculiarity of this anthrakotype process is the fact that a copy, though it may have been incorrectly exposed, can still be saved. For instance, if the image does not seem to be vigorous enough, it can be intensified in the simplest way; it is only necessary to soak the paper afresh, then dust on more color, etc.; in short, repeat the developing process as above described. In difficult cases the dusting-on may be repeated five or six times, till at last the desired intensity is obtained.

By this process, therefore, we get a positive copy of a positive original in black lines on a white ground. Of course, any other coloring material in a state of powder may be used instead of soot, and then a colored drawing on a white ground is obtained. Very pretty variations of the process may be made by using gold or silver paper, and dusting-on with different colors; or a picture may be taken in gold bronze powder on a white ground. In this way colored drawings may be taken on a gold or a silver ground, and very bright photo tracings will be the result. Some examples of this kind, that have been sent us from Vienna, are exceedingly beautiful.

Summing up the respective advantages of the two processes we have above described, we may say that "nigrography" is best adapted for copying drawings of a large size; the copies can with difficulty be distinguished from good autographs, and they do not possess the bad quality of gelatine papers--the tendency to roll up and crack. Drawings, however, which have shadow or gradated lines cannot be well produced by this process; in such cases it is better to adopt "anthrakotype," with which good results will be obtained.--*Photographic News*.

ON M. C. FAURE'S SECONDARY BATTERY.

The researches of M. Gaston Planté on the polarization of voltameters led to his invention of the secondary cell, composed of two strips of lead immersed in acidulated water. These cells accumulate, and, so to speak, store up the electricity passed into them from some outside generator. When the two electrodes are connected with any source of electricity the surfaces of the two strips of lead undergo certain modifications. Thus, the positive pole retains oxygen and becomes covered with a thin coating of peroxide of lead, while the negative pole becomes reduced to a clean metallic state.

Now, if the secondary cell is separated from the primary one, we have a veritable voltaic battery, for the symmetry of the poles is upset, and one is ready to give up oxygen and the other eager to receive it. When the poles are connected, an intense electric current is obtained, but it is of short duration. Such a cell, having half a square meter of surface, can store up enough electricity to keep a platinum wire 1 millim. in diameter and 8 centims. long, red-hot for ten minutes. M. Planté has succeeded in increasing the duration of the current by alternately charging and discharging the cell, so as alternately to form layers of reduced metal and peroxide of lead on the surface of the strip. It was seen that this cell would afford an excellent means for the conveyance of electricity from place to place, the great drawback, however, being that the storing capacity was not sufficient as compared with the weight and size of the cell. This difficulty has now been overcome by M. Faure; the cell as he has improved it is made in the following manner:

The two strips of lead are separately covered with minium or some other insoluble oxide of lead, then covered with an envelope of felt, firmly attached by rivets of lead. These two electrodes are then placed near each other in water acidulated with sulphuric acid, as in the Planté cell. The cell is then attached to a battery so as to allow a current of electricity to pass through it, and the minium is thereby reduced to metallic spongy lead on the negative pole, and oxidized to peroxide of lead on the positive pole; when the cell is discharged the reduced lead becomes oxidized, and the peroxide of lead is reduced until the cell becomes inert.

The improvement consists, as will be seen, in substituting for strips of lead masses of spongy lead; for, in the Planté cell, the action is restricted to the surface, while in Faure's modification the action is almost unlimited. A battery composed of Faure's cells, and weighing 150 lb., is capable of storing up a quantity of electricity equivalent to one horsepower during one hour, and calculations based on facts in thermal chemistry show that this weight could be greatly decreased. A battery of 24 cells, each weighing 14 lb., will keep a strip of platinum five-eighths of an inch wide, one-thirty-second of an inch thick, and 9 ft. 10 in. long, red-hot for a long time.

The loss resulting from the charging and discharging of this battery is not great; for example, if a certain quantity of energy is expended in charging the cells, 80 per cent. of that energy can be reproduced by the electricity resulting from the discharge of the cells; moreover, the battery can be carried from one place to another without injury. A battery was lately charged in Paris, then taken to Brussels, where it was used the next day without recharging. The cost is also said to be very low. A quantity of electricity equal to one horse power during an hour can be produced, stored, and delivered at any distance within 3 miles of the works for 1½d. Therefore these batteries may become useful in producing the electric light in private houses. A 1,250 horsepower engine, working dynamo-machines giving a continuous current, will in one hour produce 1,000 horse-power of effective electricity, that is to say 80 per cent. of the initial force. The cost of the machines, establishment, and construction will not be more than £40,000, and the quantity of coal burnt will be 2 lb. per hour per effective horse-power, which will cost (say) ½d. The apparatus necessary to store up the force of 1,000 horses for twenty-four hours will cost £48,000, and will weigh 1,500 tons. This price and these weights may become much less after a time. The expense for wages and repairs will be less than ¼d. per hour per horse-power, which would be £24 a day, or £8,800 a year; thus the total cost of one horse-power for an hour stored up at the works is ¾d. Allowing that the carriage will cost as much as the production and storing, we have what is stated above, viz., that the total cost within 3 miles of the works is 1½d. per horse-power per hour. This quantity of electricity will produce a light, according to the amount of division, equivalent to from 5 to 30 gas burners, which is much cheaper than gas.--*Chemical News*.

PHYSICAL SCIENCE IN OUR COMMON SCHOOLS.

[Footnote: Read before the State Normal Institute at Winona, Minnesota, April 28, 1881, by Clarence M. Boutelle, Professor of Mathematics and Physical Science in the State Normal School.]

Very little, perhaps, which is new can be said regarding the teaching of physical science by the experimental method. Special schools for scientific education, with large and costly laboratories, are by no means few nor poorly attended; scientific books and periodicals are widely read; scientific lectures are popular. But, while in many schools of advanced grade, science is taught in a scientific way, in many others the work is confined to the mere study of books, and in only a few of our common district schools is it taught at all.

I shall advocate, and I believe with good reason, the use of apparatus and experiments to supplement the knowledge gained from books in schools where books are used, the giving of lessons to younger children who do not use books, and the giving of these lessons to some extent in all our schools. And the facts which I have gathered together regarding the teaching of science will be used with all these ends in view.

Physics--using the term in its broadest sense--has been defined as the science which has for its object the study of the material world, the phenomena which it presents to us, the laws which govern (or account for) these phenomena, and the applications which can be made of either classes of related phenomena, or of laws, to the wants of man. Thus broadly defined, physics would be one of two great subjects covering the whole domain of knowledge. The entire world of matter, as distinguished from the world of mind, would be presented to us in a comprehensive study of physics.

I shall consider in this discussion only a limited part of this great subject. Phenomena modified by the action of the vital force, either in plants or in animals, will be excluded; I shall not, therefore, consider such subjects as botany or zoölogy. Geology and related branches will also be omitted by restricting our study to phenomena which take place in short, definite, measurable periods of time. And lastly, those subjects in which, as in astronomy, the phenomena take place beyond the control of student and teacher, and in which their repetition at pleasure is impossible, will not be considered. Natural philosophy, or physics, as this term is generally used, and chemistry, will, therefore, be the subjects which we will consider as sources from which to draw matter for lessons for the children in our schools.

The child's mind has the receptive side, the sensibility, the most prominent. His senses are alert. He handles and examines objects about him. He sees more, and he learns more from the seeing, than he will in later years unless his perceptive powers are definitely trained and observation made a habit. His judgment and his will are weak. He reasons imperfectly. He chooses without appropriate motives. He needs the building up and development given by educational training. *Nature points out the method.*

Sensibility being the characteristic of his mind, we must appeal to him through his senses. We must use the concrete; through it we must act upon his weak will and immature judgment. From his natural curiosity we must develop attention. His naturally strong perceptive powers must be made yet stronger; they must be led in proper directions and fixed upon appropriate objects. He must be led to appreciate the relation between cause and effects--to associate together related facts--and to state what he knows in a definite, clear, and forcible manner.

Object lessons, conversational lessons, lessons on animals, lessons based on pictures and other devices, have been used to meet this demand of the child's mental make up. Good in many respects, and vastly better than mere book work, they have faults which I shall point out in connection with the corresponding advantages of easy lessons in the elements of science. I shall not quibble over definitions. Object lessons may, perhaps, properly be said to include lessons such as it seems to me should be given--lessons drawn from natural philosophy or chemistry--but I use the term here in the sense in which it is often used, as meaning lessons based upon some object. A thimble, a knife, a watch, for instance, each of these being a favorite with a certain class of object teachers, may be taken.

The objections are:

1. Little new knowledge can be given which is simple and appropriate. Most children already know the names of such objects as are chosen, the names of the most prominent parts, the materials of which they are composed and their uses. Much that is often given should be omitted altogether if we fairly regard the economy of the child's time and mental strength. It doesn't pay to teach children that which isn't worth remembering, and which we don't care to have them remember.

2. Study of the qualities of materials is a prominent part of lessons on objects. Such study is really the study of physical science, but with objects such as are usually selected is a very difficult part to give to young children. Ask the student who has taken a course in chemistry whether the study of the qualities of metals and their alloys is easy work. Ask him how much can readily be shown, and how much must be taken on authority. Have him tell you how much or how little the thing itself suggests, and how much must he memorized from the mere book statement and with difficulty. Study of materials is good to a certain extent, but it is often carried much too far.

Consider a conversational lesson on some animal. Lessons are sometimes given on cats. As an element in a reading lesson--to arouse interest--to hold the attention--to secure correct emphasis and inflection--to make sure of the reading being good: such work is appropriate. But let us see what the effect upon the pupil is as regards the knowledge he gains of the cat, and the effect upon his habits of thought and study. The student gives some statement as to the appearance--the size--or some act of his cat. It is usually an imperfect statement drawn from the imperfect memory of an imperfect observation. And the teacher, having only a *general knowledge* of the habits of cats, can correct in only a general way. Thus habits of faulty and incorrect observation and inaccurate memory are fastened upon the child. It is no less by the correction of the false than by the presenting of the true, that we educate properly.

Besides this there is the fact that traits, habits, and peculiarities of animals are not always manifested when we wish them to be. Suppose a teacher asks a child to notice the way in which a dog drinks, for example; the child may have to wait until long after all the associated facts, the reasons why this thing was to be observed--the lesson as a whole of which this formed a part--have all grown dim in the memory, before the chance for the observation occurs.

Pictures are less valuable as educational aids than objects; at best they are but partially and imperfectly concrete. The study of pictures tends to cultivate the imagination and taste, but observation and judgment are but little exercised.

A comparison of the kind of knowledge gained in either of the above ways with that gained by a study of science as such, will make some of the advantages of the latter evident. An act of complete knowledge consists in the identifying of an attribute with a subject. Attributes of quality--of condition--of relation, may be gained from lessons in which objects or pictures are used. Attributes of action which are unregulated by the observer may be learned from the study of animals. But very little of actions and changes which can be made to take place under specified conditions, and with uniformity of result, can be learned until physical science is drawn upon.

And yet consider the importance of such study. Changes around him appeal most strongly to the child. "Why *does* this thing *do* as it *does*?" is more frequent than "Why *is* this thing as it *is*?" He sees changes of place, of form, of size, of composition, taking place; his curiosity is aroused; and he is ready to study with avidity, and in a systematic manner, the changes which his teacher may present to him. Consider the peculiarities belonging to the study of changes of any sort. The interest is held, for the mind is constantly gaining the new. The attention cannot be divided--all parts of the change, all phases of the action, must be known, and to be known must be *observed*; while in other forms of lessons the attention may be diverted for a moment to return to the consideration of exactly what was being observed before. It goes without saying that in one case quick and accurate observation, a retentive memory, and the association of causes and effects follow, and that in the other they do not.

I advocate, therefore, the teaching of physical science in our schools--*in all our schools*. Physical science taught by the experimental method.

An experiment has been defined as a question put to Nature, a question asked in *things* rather than in *words*, and so conditioned that no uncertain answer can be given. Nature says that all matter gravitates, not in words, but in the swing of planets around the sun, and in the leap of the avalanche. And men have devised ingenious machines through which Nature may tell us the invariable laws of gravitation, and give some hint as to why it is true.

There are two kinds of experiments, and two corresponding kinds of investigators.

I. In original investigation there are the following elements:

1. The careful determination of all the conditions under which the experiment takes place.

2. The observation of exactly what happens, with a painstaking elimination of all previous notions as to what ought to happen.

3. The change of conditions, one at a time, with a comparison of the results obtained with the changes made, in order to determine that each condition has been given just its appropriate weight in the experiment.

4. The classification and explanation of the result.

5. The extension of the knowledge gained by turning it to investigations suggested by what has already been learned.

6. The practical application of the knowledge gained.

II. In ordinary experiments for educational purposes the experimenter follows in a general way in the footsteps of the original investigator. There are the following elements to be considered:

1. The arrangement of conditions in general imitation of the original investigator. This arrangement needs only to be general. For example, if an original investigation were undertaken to determine the composition of a metallic oxide, the metal and the oxygen would both be carefully saved to be measured and weighed and fully tested. The ordinary experiment would be considered successful if oxygen and the metal were shown to result.

2. The careful consideration of what should happen.

3 The determination that the expected either does or does not happen, with examination of reasons and elimination of disturbing causes in the latter case.

4. The accepting as true of the classification and explanation already given. Theories, explanations, and laws are thus accepted every day by minds which could never have originated either them or the experiments from which they were derived.

The method of original investigation, strictly considered, presents many difficulties. A long course of preliminary training--a thorough knowledge of what has been done in a given field already--a quick imagination--a genius for devising forms of apparatus which will enable him to work well under particular conditions in the most simple and effective way--the faculty of suspending judgment, and of seeing what happens, all that happens, and just how it happens--patience--caution--courage--quick judgment when a completed experiment presses for an explanation--these are some of the characteristics which must belong to the original worker.

Were we all capable of doing such work there would be these advantages, among others, of studying for ourselves:

1. What we find out for ourselves we remember longer and recall more readily than what we acquire in any other way. This advantage holds true whether the facts learned are entirely new or only new to us. Almost every man whose life has been spent in study has a store of facts which he discovered, and on which he built hopes of future greatness until he found out later that they were old to the knowledge of the world he lived in. And these things are among those which will remain longest in his memory.

2. Associated facts would be learned in studying in this way which would remain unknown otherwise.

But all the advantages would be associated with disadvantages too. Long periods of time would have to be given for comparatively small results. The history of science is full of instances in which years were spent in the elaboration of some law, or principle, or theory which the school boy of to-day learns in an hour and recites in a breath. Why does water rise in a pump? Do all bodies, large and small, fall equally fast? The principles which answer and explain such questions can be made so clear and evident to the mind of a pupil that he would almost fancy they must have been known from the first instead of having waited for the hard, earnest labor of intellectual giants. And science has gone on, and for us and for our pupils would still go on, only as accompanied with numerous mistakes and disappointments.

What method shall we adopt in the teaching of science? It must differ according to the age and capacity of the pupils. An excellent modification of the method of original investigation may be arranged as follows:

The children are put in possession of all facts relating to conditions, the teacher explaining them as much as may be necessary. The experiment is performed, the pupils being required to observe exactly what takes place, the experiments selected being of such a nature that any previous judgment as to what ought to occur is as nearly impossible as may be. We predict from knowledge, real or supposed, of facts which are associated in our minds with any new subject under consideration. Children often know in a general, vague, and indefinite way that which, for the sake of a full and systematic knowledge, we may desire them to study. What they know will unconsciously modify their expectations, and their expectations in turn may modify their observations. We are apt to believe that happens which we expect will happen. There ought to be no difficulty, however, in finding simple and appropriate experiments with which the child is entirely unacquainted, and in which anything beyond the wildest guess work is, for him, impossible. The principal use which can be made of this method is in the mere observation of what takes place. Nothing which the child notices correctly need be rejected, no matter how far removed from the chief event on the object of the experiment. Care that the pupil shall see all, and separate the essential from the accidental, is all that is necessary.

But the original investigator assigns reasons, and with care the children may be allowed to attempt that. This, however, should not be carried far; incorrect explanations should be criticised; and the class should at length be given all the elements of the correct explanation which they have not determined for themselves. Later, pupils should be encouraged to name related phenomena, to mention things which they have seen happen which are due to associated causes, and to suggest variations for the experiment and tests for its explanation. Good results may be made to follow this kind of work even with very young pupils. A child grows in mental strength by using the powers he has, and mistakes seen to be such are not only steps toward a correct view of the subject under consideration, but are steps toward that habit of mind which spontaneously presents correct views at once in study which comes later in life.

Another method is this: The pupil may know what is expected to happen, as well as the conditions given, and held responsible for an observation of what does happen and a comparison of what he really observes with what he expects to observe. Explanations are usually given a class, often in books with which they are furnished, instead of being drawn from them, in whole or in part, by questioning, when physical science is studied in this way. Indeed, this method is a necessity when text books are used, unless experiments from some outside source are introduced.

Who shall perform the experiments? With young pupils everywhere, and in most of our common, and even in many of our graded schools, the experiments must be performed by the teacher. With young pupils the time is too limited, and the responsibility and necessary care too great to permit of any other plan being practical. In many of our schools the small supply of apparatus renders this necessary even with larger pupils. Added to the reasons already given is the important one that in no other way--by no other plan--can the teacher be as readily sure that his pupils observe and reason fully for themselves. In this normal school a course in physics, in which the experiments are all performed in the class room by the teacher, is followed by a course in chemistry, in which the members of the class perform the experiments for themselves in the laboratory. And, notwithstanding the age, maturity, and previous observation of the pupils, a great deal must be done both in the laboratory and in the recitation room to be sure that all that happens is seen--that the purpose is clearly held in the mind--that the reason is fully understood.

With older pupils and greater facilities, however, the experiments should be performed by the pupils themselves. Constant watchfulness is necessary, it is true, to insure to the pupil the full educational value of the experiment. With this watchfulness it can be done, and the advantages are numerous. Among them are:

1. The learning of the use and care of apparatus.

2. The learning of methods of actual construction, from materials at hand, of some of the simpler kinds of apparatus.

3. The learning of the importance of careful preparation. An experiment may be performed in a few minutes before a class which has taken an hour or more of time in its preparation. The pupil fully appreciates its importance, and is in the best condition to remember it only when he has had a part of the hard work attending that preparation. Again, conditions under which an experiment is successfully performed are often not appreciated when merely stated in words. "To prepare hydrogen gas, pass a thistle tube and a delivery tube through a cork which fit tightly in the neck of a bottle," etc., is simple enough. Let a pupil try with a cork which does not fit tightly and he will never forget that condition.

4. The learning of the importance of following directions. Chemistry, especially, is full of those cases where this means everything. Sometimes, not often in experiments performed in school, however, it may mean even life or death.

The time for experiments should be carefully considered. When performed by the teacher they should be taken up during the recitation:

1. If used as a foundation to build upon, at the beginning of the lesson.

2. If used as a summary, at the close.

3. They should be closely connected with the points which they illustrate.

4. When very short, or when so difficult as to demand the whole attention of the teacher, they may be given and afterward discussed. If long or easy, they may be discussed while the work is going on. Changes which take place slowly, as those which are brought about by the gradual action of heat, for instance, are best taken up in this latter way.

5. Exceptions may be necessary, as when experiments which demand special preparation immediately before they are presented are given when the recitation begins, or cases in which experiments are kept until near the close of a recitation, when the teacher finds that attention flags and the lesson seems to have lost its interest to the pupils as soon as the experiments have been given.

When performed by the pupils themselves, experiments should come before the recitation as a part of the preparation for the work of the class room.

Even in those cases in which the teacher performs the work, opportunity should be given, from time to time, for the performing of the experiment by the pupils themselves. This can be done in several ways. During the course in physics here I am in the habit of leaving apparatus on the table in my room for at least one day, often for a longer time, and of giving permission to my class to perform the experiments for themselves when their time permits and the nature of the experiment makes it an advantage to get a nearer view than was possible in the class work. I leave it to them to decide when to perform the experiments, or whether it is to their advantage to take the time to perform them at all. I make no attempt to watch either pupils or apparatus, although I would often assist or explain at intermissions or during the afternoon. The apparatus was largely used, and the effect on recitations was a good one. For advanced pupils, and those who can be fully trusted, the plan is a good one. The only question is the safety of the apparatus; each teacher can decide for himself regarding the advisability of the plan for his own school.

With smaller pupils their own safety may render it best to keep apparatus out of their hands, except under the immediate direction of the teacher. With all pupils that is, doubtless, the best plan where chemicals are concerned.

Another method is to allow pupils to assist the teacher in the preparation of experiments, to call occasionally upon members of the class to come forward and give the experiment in the place of the teacher, and to encourage home work relating to experiments. This latter is often spontaneous on the part of older pupils, and can be brought about with the smaller ones by the use of a little tact; many of the toys of the present day have some scientific principle at bottom; let the teacher find out what toys his young pupils have, and encourage them to use them in a scientific way.

In whatever ways experiments be used, the class should be made to consider the following elements as important in every case:

1. The purpose of the experiment. The same experiment may be performed at one time for one purpose, at another time for another. The purpose intended should be made the prominent thing, all others being subordinated to it. Many chemical reactions, for instance, can be made to yield either one of two or more substances for study or examination, or use, while it may be the purpose of the experiment to close only one of them.

2 The apparatus. All elements should be considered. The necessary should be separated from that which may vary. In cases where the various parts must have some definite relation to the others as regards size or position, all that should be considered with care. In complex apparatus the exact office of each part should be understood.

3. A clear understanding of what happens. To this I have already referred.

4. Why it happens.

5. In what other way it might be made to happen. In chemistry almost every substance can be prepared in several different ways. The common method is in most cases made so by some consideration of convenience, cheapness, or safety. Often only one method is considered in one place in a text book. In a review, however, several methods can be associated together. Tests, uses, etc., will vary, too, and should be studied with that fact in view. In physics phenomena illustrating a given principle can usually be made to take place in several different ways. Often very simple apparatus will do to illustrate some fact for which complex and costly apparatus would be convenient. In such case the study of the experiment with that fact in view becomes important to us who need to simplify apparatus as much as possible.

6. Special precautions which may be necessary. Some experiments always work well, even in the hands of those not used to the work. Others are successful--sometimes safe, even--only when the greatest care is taken. Substances are used constantly in work in chemistry which are deadly poisons, others which are gaseous and will pass through the smallest holes. In physics the experiments usually present fewer difficulties of this sort. But special care is necessary to complete success here.

7. Other things shown by the experiment. While the main object should be kept in most prominent view in all experimental work, the fullest educational value will come only when all that can be learned by the use of an experiment is carefully considered.

In selecting just the work to be taken up with a given class of children, attention must be paid to the selection of the appropriate matter to be presented and the well adapted method of presenting it. The following points should be carefully considered:

1. The matter must be adapted to the capacity of the child. This must be true both as regards the quality and the quantity. The tendency will be to teach too much when the matter presented is entirely new, but too little in many cases where the pupil already knows the subject in a general way. Matter is valuable only when given slowly enough to permit of its being fully understood and memorized, while on the other hand method is valuable only when it secures the development of attention and the various faculties of the child's mind by presenting a sufficient amount of the new.

2. The work must be based on what is already known. This, one of the best known of

the principles of teaching, is of at least as great importance in physical science as in any other department of knowledge. It seems to me in many cases to be more important here than elsewhere. It is not necessary to reach each point by passing over every other point usually considered. Lessons in electricity or sound, for instance, can be given to children who have done nothing with other parts of science. But a natural beginning must be made, and an orderly sequence of lessons adopted. Children will not do what adults would find almost impossible in covering gaps between lessons.

Science may be compared to a great temple. Pillars, each built of many curiously joined stones, standing at the very entrance, represent the departments of science so far as man has studied them. We need not dig down and study the foundations with the children; we need not study every pillar nor choose any particular one rather than some other; but we must learn something of every stone--of each great fact--in the pillar we select, be it ever so little. The original investigator climbs to stones never before reached, or boldly ventures away into the dim recesses beyond the entrance to bring back hints of what may be known and believed a hundred years hence, perhaps. The exact investigator measures each stone. Patiently and toilsomely scientific men examine them with glass and reagent. We need not do this, but we must omit none of the stones.

3. The work must be continuous. To continue the figure, the stones must be considered in some regular order. One lesson in electricity, one in sound, then one in some other department is injurious. We remember best by associated facts, and, while with the child this is less so than with the man, one great object of this work is to teach him to remember in that way.

4. Experiments should never be performed for mere show. Of two experiments which illustrate a fact equally well it is often best to select the most striking and brilliant one. The attention and interest of the child will be gained in this way when they would not be to so great an extent in any other. The point of the experiment, however, should never be lost sight of in attention to the merely wonderful in it.

With older pupils, and especially with those who use books for themselves and perform the experiments there considered, the fact that experiments demand work, downright hard work, with care, and patience, and perseverance, and courage, cannot be kept too prominently before them.

5. Every lesson should have a definite object. Not the general value of the experiment, but some *one thing* which it shows should be the object considered.

6. Each experiment should be associated with some truth expressed in words. The experiment should be remembered in connection with a definite statement in each case. The memory of either the experiment, or the principle apart from the experiment, is a species of half knowledge which should be avoided. An unillustrated principle must, when the necessity arises, be stored in the memory; and in the systematic study of books this necessity will often come. But we should never crowd this abstract work on the memory unassisted by the suggestive concrete, when the concrete aid is possible.

7. All that is taught should be true. It is not necessary to attempt to exhaust a subject, nor to attempt to teach minute details regarding it to the pupils in our schools, but it is necessary that every statement given to the pupil to be learned and remembered should contain no element of falsehood.

The student in mathematics experiences a feeling of growing strength and power when he finds, in algebra, that the formula he used in arithmetic in extracting a square root has grown in importance by leading indirectly to a theorem of which it is only one particular case--a theorem with a more definite proof, and a larger capability for use than he had thought possible. When he finds a still simpler proof for the binomial theorem in his study of the calculus, his feeling of increasing power and the desire for still greater results deepens and intensifies. Were he to find, on the contrary, that from a false notion of the means to be used in making a thing simple, his teacher in arithmetic had taught him what is false, we should approve his feeling of disgust and disappointment. Early impressions are the most lasting, and the hardest part of school work for the teacher is the unteaching of false ideas, and the correcting of imperfectly formed and partially understood ideas. I took a case from mathematics, the exact science, to illustrate this point. But I must not neglect to notice the difference between that subject and physical science. The latter consists of theories, hypotheses, and so-called laws, supported by *observed facts*. The facts remain, but time has overthrown many of the hypotheses and theories, and it will doubtless overthrow more and give us something better and truer in their place. While a careful distinction between what is known and what is believed is necessary, I should always class the teaching of accepted theories and hypotheses with the teaching of the true.

But teachers, with more of imagination than good sense, teach distinctions which do not exist, generalizations which do not generalize, and do incalculable mischief by so doing.

8. Experimental work should be thoroughly honest as to conditions and results. If an experiment is not the success you expected it would be, say so honestly, and if you know why, explain it. The pupil should be taught to know just what *is*, theory or expectation to the contrary notwithstanding. Discoveries in physical science have often originated in a search for the reason for some unexpected thing.

The relation of the study of science to books on science should be considered. For the work done with pupils before they are given books to use for themselves, any attempt to follow a text book is to be deplored. The study of the properties of matter, for instance, would be a fearful and wonderful thing to set a class of little ones at as a beginning in scientific work. Just what matter, and force, and molecules, and atoms are may be well enough for the student who is old enough to begin to use a book, but they would be but dry husks to a younger child. Many of the careful classifications and analyses of topics in text books had far better be used as summaries than in any other way; and a definition is better when the pupil knows it is true than when he is about to find out whether it is or not.

An ideal course in science would be one in which nothing should be learned but that found out by the observation of the pupil himself under the guidance of the teacher, necessary terms being given, but only when the thing to be named had been considered, and the mind demanded the term because of a felt need. Practically such a method is impossible in its fullest sense, but a closer approach to it will be an advantage.

Among the numerous good results which will follow the study of physical science are the following:

1. The cultivation of all the faculties of the child in a natural order, thus making him grow into a ready, quick, and observing man. Education in schools is too often shaped so as to repress instead of cultivate the instinctive desire for the *knowledge of things* which is found in every child.

2. The mechanical skill which comes from the preparation and use of apparatus.

3. The ability to follow directions.

4. The belief in stated scientific facts, the understanding of descriptions, diagrams, etc.

5. The habitual scientific use of events which happen around us.

6. The study of the old to find the new. The principle of the telephone, for instance, is as old as spoken language. The mere[1] pulses in the air--carrying all the characteristics of what you say--may set in vibration either the drum of my ear, or a disk of metal. How simple--and how simple all true science is--when we understand it.

[Transcribers note 1: corrected from 'more']

8. The cultivation of the scientific judgment, and the inventive powers of the mind. One great original investigator, made such by the direction given his mind in one of our common schools, would be cheaply bought at the price of all that the study of science in our schools will cost for the next quarter of a century.

8. Honesty. If there is a study whose every tendency is more in the direction of honesty and truthfulness--both with ourselves and with others--than is the study of experimental science, I do not know what it is.

Physical science, then, will help in making men and women out of our boys and girls. It is worthy of a fair, earnest trial everywhere.

A few minutes each day in which a class or a school study science in some of the ways I have indicated will give a knowledge at the end of a term or a year of no mean value. The time thus spent will have rested the pupils from their books, to which they will return refreshed, and instead of being time lost from other study the work will have been made enough more earnest and intense to make it again.

Apparatus for illustrating many of the ordinary facts of physics can be devised from materials always at hand. Many more can be made by any one skilled in the use of tools. In chemistry, the simplicity of the apparatus, and comparative cheapness of ordinary chemicals, make the use of a large number of beautiful and instructive experiments both easy and cheap.

A nation is what its trades and manufactures--its inventions and discoveries--make it; and these depend on its trained scientific men. Boys become men. Their growing minds are waiting for what I urge you to offer. Science has never advanced without carrying practical civilization with it--but it has never truly advanced save by the use of the experimental method. *And it never will*.

Let us then look forward to the time when our boys and young men--our girls and young women--shall extend the boundaries of human knowledge by its use, fitted so to do by what we may have done for them.

GEOGRAPHICAL SOCIETY OF THE PACIFIC.

This society is a recent organization, the objects of which are to encourage geographical exploration and discovery; to investigate and disseminate geographical information by discussion, lectures, and publications; to establish in this, the chief maritime city of the Western States, for the benefit of commerce, navigation, and the industrial and material interests of the Pacific slope, a place where the means will be afforded of obtaining accurate information not only of the countries bordering on the Pacific ocean, but of every part of the habitable globe; to accumulate a library of the best books on geography, history, and statistics; to make a collection of the most recent maps and charts--especially those which relate to the Pacific coast, the islands of the Pacific and the Pacific ocean--and to enter into correspondence with scientific and learned societies whose objects include or sympathize with geography.

The society will publish a bulletin and an annual journal, which will interchange with geographical and other societies. Monthly meetings are to be held, at which original papers will be read or lectures be given; and to which, as well as to the entertainments to distinguished travelers, to the conversazioni, and to the informal evenings, the fellows of the society will have the privilege of introducing their friends. The initiation fee to the society is $10; monthly dues $1; life fellowship $100.

At a meeting held at the Palace Hotel on the 12th May, the following gentlemen were elected for the ensuing year: President, Geo. Davidson; Vice-Presidents, Hon. Ogden Hoffman, Wm. Lane Booker, H.B.M. Consul, and John R. Jarboe; Foreign Corresponding Sec., Francis Berton; Home Cor. Sec., James P. Cox; Treas., Gen. C. I. Hutchinson; Sec'y, C. Mitchell Grant, F.R.G.S. The council is composed of the following: Hon. Joseph W. Winans, Hon. J.F. Sullivan, Ralph C. Harrison, A.S. Hallidie, Thos. E. Stevin, F.A.G.S., W.W. Crane, Jr., W.J. Shaw, C.P. Murphy, Thos. Brice, Edward L.G. Steele, Gerrit L. Lansing, Joseph D. Redding. The Trustees are Geo. Davidson, Wm. Lane Booker, Hon. Jno. S. Hager, Geo. Chismore, M.D., Selim Franklin.

THE BEHRING'S STRAITS CURRENTS.

It will be remembered that a short time since we mentioned the fact that W.H. Dall, of the U. S. Coast Survey, who has passed a number of years in Alaskan waters, on Coast Survey duty, denied the existence of any branch of the Kuro Shiwo, or Japanese warm stream, in Behring's Straits. That is, he failed to find evidence of the existence of any such current, although he had made careful observations. At the islands in Behring's Straits, his vessel had sailed in opposite directions with ebb and flood tide, and he thought the only currents there were tidal in their nature. The existence or non-existence of this current is an important point in Arctic research on this side of the continent.

At the last meeting of the Academy of Sciences, Prof. Davidson, of the U. S. Coast Survey, author of the "Alaska Coast Pilot," refuted Dr. Dall's opinion of the non-existence of a branch of the Kuro Shiwo, or Japanese warm stream, from the north Pacific into the Arctic Ocean, through Behring's Straits. He said that in 1857 he gave to the Academy his own observations, and recently he had conferred with Capt. C.L. Hooper, who commanded the U. S. steamer Thomas Corwin, employed as a revenue steam cruiser in the Arctic and around the coast of Alaska. Capt. Hooper confirms the opinions of all previous navigators, every one of which, except Dr. Dall, say that a branch of this warm stream passed northward into the Arctic through Behring's Strait. It is partly deflected by St. Lawrence Island, and closely follows the coast on the Alaskan side, while a cold current comes out south, past East Cape in Siberia, skirting the Asiatic shore past Kamschatka, and thence continues down the coast of China. He said ice often extended several miles seaward, from East Cape on the Asiatic side of Behring Strait, making what seamen call a false cape, and indicating cold water, while no such formation makes off on the American side, where the water is 12 degrees warmer than on the Asiatic shore off the Diomede islands, situated in the middle of Behring's Strait, the current varies in intensity according to the wind.

Frequently it is almost nothing for several days, when after a series of southerly winds the shallow Arctic basin has been filled, under a heavy pressure, with an unusual volume of water, and a sudden change to northerly winds, makes even a small current setting southward for a few days, just as at times the surface currents set out our Golden Gate continuously for 24 and 48 hours, as shown by the United States Coast Survey tide gauges. Whalers report that the incoming water then flows in, under the temporary outflowing stream.

Old trees, of a variety known to grow in tropical Japan, are floated into the Arctic basin as far as past Point Barrow, on the American side, but none are found on the Asiatic side, or near Wrangell Land, where a cold stream exists, and ice remains late in the season. On the northern side of the Aleutian islands are found cocoanut husks and other tropical productions stranded along the beaches. The American coast of Alaska has a much warmer climate than the Asiatic coast of Siberia, and the American timber line extends very far north. The ice opens early in the season on the American side, and invariably late on the Asiatic.

Capt. C. L. Hooper says that when just north of Behring's Strait, off the American coast, in the Arctic basin, the U.S. steamer Thomas Corwin, when becalmed for 24 hours, drifted 40 miles to the northward. From all these, and other facts, and the unanimous testimony of American whalemen, who have for years spent many months annually in the Arctic, and from his own observations, he argued that a branch of the Kuro-Shiwo or Japanese warm stream, unquestionably runs northward through Behring's Strait into the Arctic basin along the northwestern coast of Alaska.

Prof. Davidson then called to mind the testimony in regard to the existence of Plover Island, between Herald Island and Wrangell Land, which he said was first made public through this academy. The evidence of Capts. Williams and Thomas Long were recited and highly praised. One of the officers of Admiral Rodgers' expedition climbed to near the top of Herald Island, at a time of great refraction, when probably a false horizon existed, and hence did not see Plover Island, although Wrangell Land was in sight.

Prof. Davidson thinks all the authorities are against Dr. Dall, who attributes the warm current he observed on the American coast to water from the Yukon River and to the large expanse of shallow water exposed to the sun's rays. As Dall's observations only covered a few days of possibly exceptional weather, and the whalers and Captain Hooper's cover vastly longer periods, and whalers all say it is a pretty hard thing to beat southward through Behring's Strait, owing to the northerly current setting into the Arctic, we are forced to the conclusion that Dr. Dall has mistaken the exception for the rule, and his conclusions are therefore erroneous. When, in 1824, Wrangell went north, he, like others, always found broken ice and considerable open water. In 1867, when Capt. Thomas Long made his memorable survey of the coast of Wrangell Land, the season was an exceptionally open one, and in California we had heavy rains, extending into July.

EXPERIMENTAL GEOLOGY.

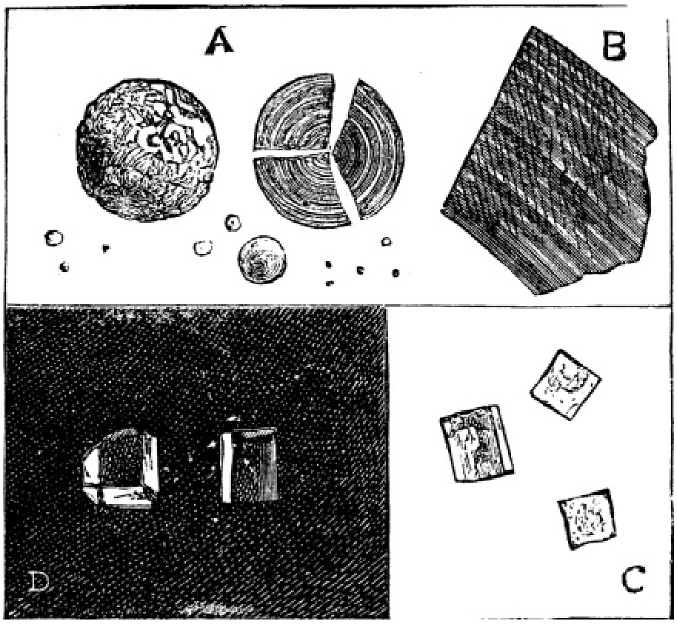
ARTIFICIAL PRODUCTION OF CALCAREOUS PISOLITES AND OOLITES.

Mr. Stanislas Meunier communicates to *Le Nature* an account of some interesting specimens of globular calcareous matter, resembling pisolites or peastones both in appearance and structure, which were accidentally formed as follows: The Northern Railway Company, France, desiring to purify some calciferous water designed for use in steam boilers, hit upon the ingenious expedient of treating it with lime water whose concentration was calculated exactly from the amount of lime held in the liquid to be purified. The liquids were mixed in a vast reservoir, to which they were led by parallel pipes, and by which they were given a rapid eddying motion. The transformation of the bicarbonate into neutral carbonate of lime being thus effected with the accompaniment of a circling motion, the insoluble salt which precipitated, instead of being deposited in an amorphous state, hardened into globules, the sizes of which were strictly regulated by the velocity of the currents. Those that have been formed at one and the same operation are uniform, but those formed at different times vary greatly--their diameters varying by at least one millimeter to one and a half centimeters. The surface of the smaller globules is smooth, but that of the larger ones is rough. Even by the naked eye, it may be seen that both the large and small globules are formed of regularly superposed concentric layers. If an extremely thin section be made through one of them it is found that the number of layers is very great and that they are remarkably regular (A). By the microscope, it has been ascertained that each layer is about 0.007 of a millimeter in thickness.

On observing it under polarized light the calcareous substance is discovered to be everywhere crystallized, and this suggests the question whether the carbonate has here taken the form of aragonite or of calcite. Examination has shown it to be the latter. The density of the globules (2.58) is similar to that of ordinary varieties of calcite. It is probable that if the operation were to take place under the influence of heat, under the conditions above mentioned, aragonite would be formed. It is hardly necessary to dwell upon the possible geological applications of this mode of forming calcareous oolites and pisolites.

ON CRYSTALS OF ANHYDROUS LIME.

Some time ago it was discovered that some limestone, which had been submitted for eighteen months to a heat of nearly 1,000 degrees in the smelting furnaces of Leroy-Descloges (France), had given rise to perfectly crystallized anhydrous lime. Figure C shows three of these crystals magnified 300 diameters. It will be noticed that they have a striking analogy with grains of common salt. They are, in fact, cubes (often imperfect), but do not polarize light, as a substance of the first crystalline system should. However, it is rarely the case that the crystals do not have *some* action on light. Most usually, when the two Nicol prisms are crossed so as to cause extinction, the crystals present the appearance shown at D. That is to say, while the central portion is totally inactive there are seen on the margins zones which greatly brighten the light.



A and B.--Calcareous Pisolites and Oolites produced artificially. A.--External aspect and section of a Pisolite. B.--Details of internal structure as seen by the microscope.

C and D.--Crystals of anhydrous Lime obtained artificially. C.--Crystals seen under the microscope in the natural light. D.--Crystals seen under the microscope in polarized light.

The phenomenon is explained by the slow carbonization of the anhydrous lime under the influence of the air; the external layers passing to the state of carbonate of lime or Iceland spar, which, as well known, has great influence on polarized light. This transformation, which takes place without disturbing the crystalline state, does not lead to any general modification of the form of the crystals, and the final product of carbonization is a cubic form known in mineralogical language as *epigene*. As the molecule of spar is entirely different in form from the molecule of lime, the form of the crystal is not absolutely preserved, and there are observed on the edges of the epigene crystal certain grooves which correspond with a loss of substance. These grooves are quite visible, for example, on the crystal to the left in Fig. D.

Up to the present time anhydrous lime has been known only in an amorphous state. The experiment which has produced it in the form noted above would doubtless give rise to crystallized states of other earthy oxides likewise, and even of alkalino-earthy oxides.

COCCIDÆ.

[Footnote: A paper recently read before the California Academy of Sciences.]

By DR. H. BEHR.

With the exception of Hymenoptera there is no group of insects that interfere in so many ways in good and evil with our own interests, as that group of Homoptera called Coccidæ.

But while the Hymenoptera command our respect by an intellect that approaches the human, the Coccus tribe possesses only the lowest kind of instinct, and its females even pass the greater part of their lives in a mere vegetation state, without the power of locomotion or perception, like a plant, exhibiting only organs of assimilation and reproduction.

But strange to say, these two groups, otherwise so very dissimilar, exhibit again a resemblance in their product. Both produce honey and wax.

It is true, the honey of this tribe is almost exclusively used by the ants. But I have tasted the honey-like secretion of an Australian lecanium living; on the leaves of Eucalyptus dumosus; and the manna mentioned in Scripture is considered the secretion of Coccus manniparus (Ehrenberg) that feeds on a tamarix, and whose product is still used by the native tribes round Mount Sinai.

Several species of Coccides are used for the production of wax; many more, among which the Cochenill, for dyes.

All these substances can be obtained in other ways, even the Cochenill is to a great extent superseded by aniline dyes, but in regard to one production, indispensable to a great extent, we are entirely dependent on some insects of this family; it is the Shellac, lately also found in the desert regions around the Gila and Colorado on the Larrea Mexicana. You will remember that excellent treatise on this variety of Shellac, written by Professor J.M. Stillman at Berkeley, on its chemical peculiarities.

But all these different forms of utility fall very lightly in weight, and can not even be counted as an extenuating circumstance, when we compare them to the enormous evils brought on farmer and gardener by the hosts of those Coccides that visit plantations, hothouses, and orchards.

To combat successfully against these insect-pests we have first to study their habits and then adapt to them our remedies, which you will see are more effective when well administered than those which we possess against insect pests of other classes.

I give here only the outlines of their natural history, peculiarities that are common to all, for it would be impossible to go into detail. Where there are exceptions of practical importance I will mention them.

In countries with a well defined winter the winged males appear as soon as white frosts are no more usual, and copulate with the unwieldy limbless female, that looks more like a gall or morbid excrescence, than a living animal. Shortly after the young ones are perceptible near the withered body of their mother, covered by waxy secretions that look somewhat like a feathery down.

These young ones are lively enough, they move about with agility, and it is not till high summer that they fasten themselves permanently, and lose feet and antennae, organs of locomotion and perception that are no more of any use to them. (There is a slight difference in this regard between different genera, as for instance, Coccus and Dorthesia retain these organs in different degrees of imperfection, Lecanium and Aspidiotus losing every trace of them.)

In this limbless, senseless state the females remain fall and winter. Toward the end of winter these animated galls begin to swell, and those containing males enter the state of the chrysalis, from which the males emerge at the beginning of the warm season and fecundate the gall-like females, which undergo neither chrysalis state nor any other change, but die, or we may call it dissolve into their offspring, for there scarcely remains anything of them, except a pruinous kind of down, after having given birth to the young ones.

Now we come to the practical deduction from these facts. It is clear that the only time when the scalebug can emigrate and infest a new tree is the time when it is a larva, that is, when it has the power of locomotion. In countries with a pronounced winter this time begins much later than with us, but it ends about the same time, that is, the beginning of August. I have seen the male of Aspidiotus in February, so that the active larva may be expected in March, and the active Lecanium Hesperidum I have seen last year, June 27, at Colonel Hooper's ranch in Sonoma County. We may safely fix the time of the active scalebug from March to August.

Notwithstanding the agility of the young scalebug, the voyage from one tree to another, considering the minute size of the traveler, is an undertaking but seldom succeeding, but one female bug, if we take into account its enormous fertility, is sufficient to cover with its grandchildren next year a tree of moderate size.

Besides there is another and much more effective way of transmigration by the kind assistance of the ant who colonizes the scalebug as well for its wax as it colonizes the Aphis for its honey. Birds on their feathers and the gardener himself on his dress contribute to spread them.

But even the ant can not transplant the scalebug when it is once firmly fixed by its rostrum.

It is evident, therefore, that the time for the application of insecticides is the time when all the scalebugs are fixed, that is about the end of July or beginning of August. All previous application will clean the tree or plant only for a time, and does not prevent a more or less numerous immigration from the neighboring vegetation, especially if an ant-hill is not far off.

As to the insecticide, there are to be applied two very effective ones, each with its advantages and disadvantages.

1. Petroleum and its different preparations.

2. Lye or soap.

The petroleum is the best disinfectant. It can safely be applied to any cutting or stem, as long as it is not planted, but is one of the most invidious substances when applied to vegetation in the garden, or fields. If effectively applied, it can not be prevented from running down the bark of the tree and entering the ground, where every drop binds a certain amount of earth to an insoluble substance, in which state it remains for ever. With every application the quantity of these insoluble compounds is augmented and sterility added.

If I am not mistaken, it was near Antwerp--at least I am certain it was in Belgium--where the first experience of this kind is recorded.

In France, preparations of coal tar have been recommended and have been lately used in the form of a paint. May be that in this form the substance is not so apt to enter into combinations with the soil. At any rate, the method is of too recent a date to permit any conclusions about the final result of these applications, as the invidious nature of the substance produces, by gradual accumulation, its effects, which are not perceived until they are irreparable.

2. Lye or soap. The application of these insecticides requires more care, and is therefore more troublesome. But instead of attracting fertility from the soil, they add to it. In Southern Europe soap and water has been for many years the remedy against the Lecanium Hesperidum. The method applied by the farmers in Portugal, as described to me by Dr. Bleasdale, is perhaps the most perfect one. The Portuguese have very well observed that the colonization of scalebugs always begins at the lowest end of the trunk and pretend, therefore, that the scalebug comes out of the ground. This, of course, is not the case, but may their interpretation be an error, they have been practical enough in utilizing their observation about the invasion beginning near the roots. They knead a ring of clay round the tree, in which ring the soap water runs when they wash the tree, and besides, they fill frequently the little ditch formed by this ring.

This arrangement of course is only possible in climates of a rainy summer.

As it is our object to make our knowledge as available as possible for practical purposes, I repeat for the benefit of cultivators the advice, without repeating the reasoning:

1. Use the petroleum for disinfecting imported trees and cuttings:

2. Use soap for cleaning trees planted in your orchard.

3. If you must use the petroleum in your garden, use it in August, when a single application is sufficient.

AGRICULTURAL ITEMS.

The exportation of dried apples from this country to France has greatly increased of late years, and now it is said that a large part of this useful product comes back in the shape of Normandy cider and light claret.

A.B. Goodsell says in the *New York Tribune*: "Put your hen feed around the currants. I did this twice a week during May and June, and not a currant worm was seen, while every leaf was eaten off other bushes 150 feet distant, and not so treated."

Buckwheat may be made profitable upon a piece of rough or newly cleared ground: No other crop is so effective in mellowing rough, cloddy land. The seed in northern localities should be sown before July 12; otherwise early frosts may catch the crops. Grass and clover may sometimes be sown successfully with buckwheat.

The London News says: "Of all poultry breeding, the rearing of the goose in favorable situations is said to be the least troublesome and most profitable. It is not surprising, therefore, that the trade has of late years been enormously developed. Geese will live, and, to a certain extent, thrive on the coarsest of grasses."

When a cow has a depraved appetite, and chews coarse, indigestible things, or licks the ground, it indicates indigestion, and she should have some physic. Give one pint and a half of linseed oil, one pound of Epsom salts, and afterward give in some bran one ounce of salt and the same of ground ginger twice a week.

Asiatic breeds of fowl lay eggs from deep chocolate through every shade of coffee color, while the Spanish, Hamburg, and Italian breeds are known for the pure white of the eggshell. A cross, however remote, with Asiatics, will cause even the last-named breeds to lay an egg slightly tinted.

In setting out currant bushes care should be exercised not to place any buds under ground, or they will push out as so many suckers. Currants are great feeders, and should be highly manured. To destroy the worm, steep one table-spoonful of hellebore in a pint of water, and sprinkle the bushes. Two or three sprinklings are sufficient for one season.

Mr. Joseph Harris, of Rochester, makes a handy box for protecting melons and cucumbers from insect enemies. Take two strips of board of the required size, and fasten them together with a piece of muslin, so the muslin will form the top and two sides of the box. Then stretch into box form by inserting a small strip of wood as a brace between the two boards. This makes a good, serviceable box, and, when done with for the season, it can be packed into a very small space, by simply removing the brace and bringing the two board sides together. As there is no patent on the contrivance, anybody can make the boxes for himself.

Mr. C. S. Read recently said before the London Fanners' Club: "American agriculturists get up earlier, are better educated, breed their stock more scientifically, use more machinery, and generally bring more brains to bear upon their work than the English farmer. The practical conclusion is, that if farmers in England worked hard, lived frugally, were clad as meanly as those of the States, were content to drink filthy tea three times a day, read more and hunted less, the majority of them may continue to live in the old country."--*N. E. Farmer*.

TIMBER TREES.

A paper was read by Sir R. Christison at the last meeting of the Edinburgh Botanical Society upon the "Growth of Wood in 1880." In a former paper, he said, he endeavored to show that, in the unfavorable season of 1879, the growth of wood of all kinds of trees was materially less than in the comparatively favorable season of 1878. He had now to state results of measurements of the same trees for the recent favorable season of 1880. The previous autumn was unfavorable for the ripening of young wood, and the trees in an unprepared condition were exposed during a great part of December, 1879, to an asperity of climate unprecedented in this latitude. This might have led one to expect a falling off in the growth of wood, and it appeared, from comparison of measurements, that, with very few exceptions, the growth of wood last year was even more below the average of favorable years than that of the bad year, 1879. Thus, in fifteen leaf-shedding trees of various species, exclusive of the oak, the average growth of trunk girth in three successive years was: 1878, 8-10ths; 1879, 45-100ths; 1880, 3-10ths and a half. In four specimens of the oak tribe, the growth was: 1878, 8-10ths; 1879, 77-100ths; 1880, 54-100ths. In twenty specimens of the evergreen Pinaceae the growth was: 1878, 8-10ths; 1879, 7-10ths; 1880, 6-10ths and a half. After giving details in regard to particular trees, Sir Robert stated, as general deductions from his observations, that leaf-shedding trees, exclusive of the oak, suffered most; that the evergreen Pinaceae suffered least; and that there was some power of resistance on the part of the oak tribe which was remarkable, the power of resistance of the Hungary oak being particularly deserving of attention. In another communication on the "extent of the season of growth," Sir Robert stated, as the result of observations on five leaf-shedding and five evergreen trees, that in the case of the former, even in a fine year, the growth of wood was confined very nearly, if not entirely, to the months of June, July, and August; while in the case of the latter growth commenced a month sooner, terminating, however, about the same time. Mr. A. Buchan said it was proposed that the inquiry should be taken up more extensively over Scotland.

MEDICAL USES OF FIGS.--Prof. Bouchut speaks (

Comptes Rendus

) of some experiments he has made, going to show that the milky juice of the fig-tree possesses a digestive power. He also observed that, when some of this preparation was mixed with animal tissue, it preserved it it from decay for a long time. This fact, in connection with Prof. Billroth's case of cancer of the breast, which was so excessively foul smelling that all his deodorizers failed, but which, on applying a poultice made of dried figs cooked in milk, the previously unbearable odor was entirely done away with, gives an importance to this homely remedy not to be denied.--

Medical Press and Circ.

BLOOD RAIN.

The sensibilities of ignorant or superstitious people have at various times been alarmed by the different phenomena of so-called blood, ink, or sulphur rains. Ehrenberg very patiently collected records of the most prominent instances of these, and published them in his treatise on the dust of trade winds. Some, it is known, are due to soot; others, to pollen of conifers or willows; others, to the production of fungi and algae.

Many of the tales of the descent of showers of blood from the clouds which are so common in old chronicles, depends, says Mr. Berkeley, the mycologist, upon the multitudinous production of infusorial insects or some of the lower algae. To this category belongs the phenomenon known under the name of "red snow." One of the most peculiar and remarkable form, which is apparently virulent only in very hot seasons, is caused by the rapid production of little blood-red spots on cooked vegetables or decaying fungi, so that provisions which were dressed only the previous day are covered with a bright scarlet coat, which sometimes penetrates deeply into their substance. This depends upon the growth of a little plant which has been referred to the algae, under the name of *Palmellae prodigiosa*. The rapidity with which this little plant spreads over meat and vegetables is quite astonishing, making them appear precisely as if spotted with arterial blood; and what increases the illusion is, that there are little detached specks, exactly as if they had been squirted from a small artery. The particles of which the substance is composed have an active molecular motion, but the morphosis of the production has not yet been properly observed. The color of the so-called "blood rain" is so beautiful that attempts have been made to use it as a dye, and with some success; and could the plant be reproduced with any constancy, there seems little doubt that the color would stand. On the same paste with the "blood-rain" there have been observed white, blue, and yellow spots, which were not distinguishable in structure and character.

TOPICAL MEDICATION IN PHTHISIS.

Dr. G.H. Mackenzie reports in the *Lancet* an acute case of phthisis which was successfully treated by him by causing the patient to respire as continuously as possible, through a respirator devised for the purpose, an antiseptic atmosphere. The result obtained appears to bear out the experiments of Schüller of Greifswald, who found that animals rendered artificially tuberculous were cured by being made to inhale creosote water for lengthened periods. Intermittent spraying or inhaling does not produce the same result. In order to insure success the application to the lungs must be made *continuously*. For this purpose Dr. Mackenzie has used various volatile antiseptics, such as creosote, carbolic acid, and thymol. The latter, however, he has discarded as being too irritating and inefficient. Carbolic acid seems to be absorbed, for it has been detected freely in the urine after it had been inhaled; but this does not happen with creosote. As absorption of the particular drug employed is not necessary, and therefore not to be desired, Dr. Mackenzie now uses creosote only, either pure or dissolved in one to three parts of rectified spirits. "Whether," says he, "the success so far attained is due to the antidotal action of creosote and carbolic acid on a specific tubercular neoplasm, or to their action as preventives of septic poisoning from the local center in the lungs, it is certain that their continuous, steady use in the manner just described has a decidedly curative action in acute phthisis, and is therefore, worthy of an extended trial."

ON THE LAW OF AVOGADRO AND AMPERE.

The Scientific American Supplement of May 14,1881, contains, under this head, Mr. Wm. H. Greene's objections to my demonstration (in No. 270 of the same paper) of the error of Avogadro's hypothesis. The most important part of my argument is based on the evidence afforded by the compound cyanogen; and Mr. Greene, directing his attention to this subject in the first place, states that because cyanogen combines with hydrogen or with chlorine, without diminution of volumes, I have concluded that the hypothesis falls to the ground. This statement has impressed me with the conviction that Mr. Greene has failed to perceive the difficulty which is at the bottom of the question, and I will, therefore, present the subject more fully and comprehensively.

The molecule of any elementary body is, on the ground of the hypothesis, assumed to be a compound of two atoms, and the molecule of carbon consequently C_2=24; that of nitrogen N_2=28. Combination of the two, according to the same hypothesis, takes place by substitution; the atoms are supposed to be set free and to exchange places, forming a new compound different from the original only in this: that each new particle contains an atom of each of the two different substances, while each original particle consists of two identical atoms. The product is, therefore, assumed to be, and can, under the circumstances, be no other than particles of the composition CN and weight 26. These particles are molecules, according to the definition laid down, just as C_2 and N_2; but there is this essential difference, that the specific gravity of cyanogen gas, 26, coincides with the molecular weight, while the assumed molecular weight, N_2=28, is twice as great as the specific gravity of the gas, N=14.

In using the term molecular weight, it is to be remembered that it does not express the weight of single molecules, but only their relative weight, millions of millions molecules being contained in the unit of volume. But on the hypothesis that there is the same number of molecules in the same volume of any gas, the specific gravities of gases can be, and are, identified with their molecular weights, and, on the ground of the hypothesis again, the unit of the numbers which enter into every chemical reaction and constitute the molecular weight, is stipulated to be that contained in two volumes.

The impossibility of the correctness of the hypothesis is now revealed by the fact just demonstrated, that in the case of nitrogen the specific gravity does not coincide with the molecular weight. If equal volumes contain the same number of molecules, the specific gravities and the molecular weights must be the same; and if the specific gravities and molecular weights are not the same, equal volumes cannot contain the same number of molecules. The assumed molecular weight of nitrogen is twice as great as the specific gravity, but the molecular weight and the specific gravity of cyanogen are identical; the number of molecules contained in one volume of cyanogen must, therefore, necessarily be twice as great as the number contained in one of nitrogen, and this is fully and completely borne out by the chemical facts.

In saying that when cyanogen combines with chlorine there is naturally no condensation, Mr. Greene has no idea that this natural law is fatal to his artificial law of Avogadro and Ampere; "for," continues he, "the theory is fulfilled by the actual reaction." It is not. The theory requires two vols. of cyanogen and two vols. of chlorine, that is, the unit of numbers, to enter into reaction and to produce two vols. of the compound. But they produce four vols., and the non-condensation is therefore in opposition to the theory. It is true beyond doubt that the molecular weight of cyanogen chloride is contained in two volumes, in spite of the hypothesis, not on the ground of it; two vols. + two vols., producing four vols.; two vols. could, theoretically, contain only half the unit of numbers, and there seems to be no escape from the following general conclusions:

1. Two vols. of CNCl, representing the unit of numbers, the constituent weights, C=12, N=14, Cl=35.5, must each, likewise, represent the same number; the molecular weight is, therefore, contained in one vol. of N or Cl, but in two of CNCl and equal numbers are not contained in equal volumes.

2. The weights N=14, Cl=35.5 occupy in the free state one volume, but in the combination, CNCl, two volumes; their specific gravity is, therefore, by chemical action reduced to one half. The fact thus elicited of the variability and variation of the specific gravity is of fundamental importance and involves the irrelevancy of the mathematical demonstration of the hypothesis. In this demonstration the specific gravity is assumed to be constant, and this assumption not holding good, and the number of molecules in unit of volume being reduced to one half when the specific gravity is reduced to the same extent by chemical action, it is obvious that the mathematical proof must fail. Mr. Greene states that I have proceeded to demolish C. Clerk Maxwell's conclusion from mathematical reasoning. This is incorrect; I have found no fault with the conclusion of the celebrated mathematician, and consider his reasoning unimpeachable. I am also of opinion that he is entitled to great credit and respect for the prominent part he has taken in the development of the kinetic theory, and further think that it was for the chemists to produce the fact of the variability of the specific gravities, which they would probably not have failed to do but for the prevalence of Avogadro's hypothesis, which is virtually the assertion of the constancy of the specific gravities.

3. The unit of numbers being represented by $Cl=35.5$, it is likewise represented by $H=1$, and as the product of the union of the two elements is HCl, 36.5 = two vols., combination takes place by addition and not by substitution; consequently are

4. The elementary molecules not compounds of atoms? And the distinction between atoms and molecules is an artificial one, not justified by the natural facts.

5. Is the molecular weight not in every instance = two volumes?

These conclusions overthrow all the fundamental assumptions on which the hypothesis rests, and leave it, in the full meaning of the term, without support. Though Mr. Greene states that my arguments are based upon entirely erroneous premises, he has not even attempted to invalidate a single one of my premises.

As he considers the non-condensation to be natural in the case of cyanogen and chlorine, the condensation of two vols. of HCl + two vols. of H_3N to two vols. of NH_4Cl ought to appear to him unnatural. He, however, contends for it, and tries, on this solitary occasion, to strengthen his opinion by authority, though the proof, if it could be given, that ammonium chloride at the temperature of volatilization is decomposed into its two constituents, would be insufficient to uphold the theory.

The ground on which Mr. Greene assumes a partial decomposition at 350° C. is the slight excess of the observed density (14.43) over that corresponding to four vols. (13.375). There is, however, a similar slight excess in the case of the vapor of ammonium cyanide, the same values being respectively 11.4 and 11; and as this compound is volatile at 100° C and, at the same time, is capable to exist at a very high temperature, being formed by the union of carbon with ammonia, nobody has ever, as far as I am aware, maintained that it is completely or partially decomposed at volatilization. The excess of weight not being due, therefore, to such cause in this case, it cannot be due to it in the other.

The question being whether the molecular weight of ammonium chloride is two vols. or four vols., an idea of the magnitude of the assumed decomposition is conveyed by the proportion of the volume of the decomposed salt to the volume of the non-decomposed, and Mr. Greene's quotation of the percentage of weight is irrelevant and misleading, and his number not even correct. A mixture containing

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   1.055 vols. of spec. gr.  26.75  =  28.22 and
  12.32   "    "    "    "   13.375 = 164.78
  ------                             ------
  13.375  "                          193
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has the spec. gr. 193 / 13.375 = 14.43. The proportion in one vol. of the undecomposed to the decomposed salt is, therefore, as 1 to 11.68 and the percentage of volume of the former 0.0789, and that of weight 28.22 / 193 = 0.146, and not 0.16.

It is not easy to imagine why a small fraction of the heavy molecules should be volatilized undecomposed, the temperature being sufficient to decompose the great bulk. Marignac assumes, indeed, partial decomposition, but the difficulties which he encountered in making the experiments, on the results of which his opinion rests, were so great that he himself accords to the numbers obtained by him only the value of a rough approximation.

The heat absorbed in volatilization will comprise the heat of combination as well as of aggregation, if decomposition takes place, and will therefore be the same as that set free at combination. Favre and Silbermann found this to be 743.5 at ordinary temperature, from which Marignac concludes that it would be 715 for the temperature 350°; he found as the heat of volatilization 706, but considers the probable exact value to be between 617 and 818.[1]

[Footnote 1: See *Comptes Rendus*, t. lxvii., p. 877.]

An uncertainty within so wide a range does not justify the confidence of Mr. Greene which he expresses in these words: "It is, therefore, extremely probable that ammonium chloride is almost entirely dissociated, even at the temperature of volatilization." By Boettinger's apparatus a decomposition may possibly have been demonstrated, but it remains to be seen whether it is not due to some special cause.

When Mr. Greene says that the relations between the physical properties of solids and liquids and their molecular composition can in no manner affect the laws of gases, nobody is likely to dissent; but the conclusion that their discussion is foreign to the question of the number of molecules in unit of volume does by no means follow. If the specific gravity of a solid or the weight of unit of volume represents a certain number of molecules, and is found to occupy two volumes in a compound of the solid with another solid, the number of molecules in one volume is reduced to one half. This I have shown to be the case in a number of compounds, and the decrease of the specific gravity with increase of the complexity of composition appears to be a general law, as may be concluded from the very low specific gravity of the most highly organized compounds, for instance the fatty bodies, the molecules of which, being composed of very many constituents, are of heavy weight; and likewise the compounds which occur in combination with water and without it, the simpler compound having invariably a greater specific gravity than the one combined with water; for instance:

BaH_2O_2	sp. gr.	4.495
" " + $8H_2O$	"	1.656
$S_2H_2O_2$	"	3.625
" " + $8H_2O$	"	1.396
$FeSO_4$	"	3.138
" + $7H_2O$	"	1.857

and so in every other case. This is now a recurrence of what takes place in gases, and proves the fallacy of the hypothesis; for if these compounds could be volatilized the vapor densities would necessarily vary in the inverse proportion of the degree of composition.

The reproach that Berthelot has been endeavoring for nearly a quarter of a century to hold back the progress of scientific chemistry, is a great and unjustifiable misrepresentation of the distinguished chemist and member of the Institute of France, who has done so much for thermo-chemistry, and the more unfortunate as it seems to serve only the purpose of a prelude to the following sentences: "But Mr. Vogel cannot claim, as can Mr. Berthelot, any real work or experiment, however roughly performed, suggested by the desire to prove the truth of his own views. Let him not, then, bring forth old and long since explained discrepancies, ... but when he will have discovered new or overlooked facts ... chemists will gladly listen." ... Mr. Greene is here no longer occupied to investigate whether what I have said concerning Avogadro's hypothesis is true or false, but with myself he has become personal, and in noticing his remarks my sole object is to contend against an error which is much prevalent. If, according to Mr. Greene, the real work of science consists in experimenting, and conclusions unsupported by our own experiments have no value, it does not appear for what purpose he has published his answer to my paper; an experiment of his, settling Marignac's uncertain results, would have justified the reliance he places on them. The ground he takes is utterly untenable. Experiments are necessary to establish facts; without them there could be no science, and the highest credit is due to those who perform successfully difficult or costly experiments. Experimenting is, however, not the aim and object of science, but the means to arrive at the truth; and discoveries derived from accumulated and generally accepted facts are not the less valuable on account of not having been derived from new and special experiment.

It is, further, far from true that the real work of science consists in experimenting; mental work is not less required, and the greatest results have not been obtained by experimenters, but by the mental labor of those who have, from the study of established facts, arrived at conclusions which the experimenters had failed to draw. This is naturally so, because a great generalization must explain all the facts involved, and can be derived only from their study; but the attention of the experimenter is necessarily absorbed by the special work he undertakes. I refer to the three greatest events in science: the discovery of the Copernican system, the three laws of Kepler, and Newton's law of gravitation, none of which is due to direct and special experimentation. Copernicus was an astronomer, but the discovery of his system is due chiefly to his study of the complications of the Ptolemaic system. Kepler is a memorable witness of what can be accomplished by skillful and persistent mental labor. "His discoveries were secrets extorted from nature by the most profound and laborious research." The discovery of his third law is said to have occupied him seventeen years. Newton's great discovery is likewise the result of mental labor; he was enabled to accomplish it by means of the laws of Kepler, the laws of falling bodies established by Galileo, and Picard's exact measurement of a degree of a meridian.

If, then, mental work is as indispensable as experimental, it is not less true that there are men more specially fitted for the one, others for the other, and the best interests of science will be served when experiments are made by those specially adapted, skillful, and favorably situated, and the possibly greatest number of men, able and willing to do mental work, engage in extracting from the accumulated treasures of experimental science all the results which they are capable to yield. Any truth discovered by this means is clear gain, and saves the waste of time, labor, and money spent in unnecessary experiment. Mr. Greene's zeal for experiment and depreciation of mental work would be in order, if ways and means were to be found to render the advancement of science as difficult and slow as possible; they are decidedly not in the interest of science, and can not have been inspired by a desire for its promotion.

As the evidence of the specific heats of the fallacy of Avogadro's hypothesis involves lengthy explanations, the subject is reserved for another paper.

San Francisco, Cal., May, 1881.

E. VOGEL.

DYEING REDS WITH ARTIFICIAL ALIZARIN.

By M. MAURICE PRUD'HOMME.

Since several years, the methods of madder dyeing have undergone a complete revolution, the origin of which we will seek to point out. When artificial alizarin, thanks to the beautiful researches of Graebe and Liebermann, made its industrial appearance in 1869, it was soon found that the commercial product, though yielding beautiful purples, was incapable of producing brilliant reds (C. Koechlin). While admitting that the new product was identical with the alizarin extracted from madder, we were led to conclude that in order to produce fine Turkey reds, the coloring matters which accompany alizarin must play an important part. This was the idea propounded by Kuhlmann as far back as 1828 (*Soc. Ind. de Mulhouse*, 49, p. 86). According to the researches of MM. Schützenberger and Schiffert, the coloring matters of madder are alizarin, purpurin, pseudopurpurin, purpuroxanthin, and an orange matter, which M. Rosenstiehl considers identical with hydrated purpurin. Subsequently, there have been added to the list an orange body, purpuroxantho-carbonic acid of Schunck and Roemer, identical with the munjistin found by Stenhouse in the madder of India. It was known that purpuroxanthin does not dye; that pseudopurpurin is very easily transformed into purpurin, and the uncertainty which was felt concerning hydrated purpurin left room merely for the hypothesis that Turkey-red is obtained by the concurrent action of alizarin and purpurin. In the meantime, the manufacture of artificial alizarin became extended, and a compound was sold as "alizarin for reds." It is now known, thanks to the researches of Perkin, Schunck, Roemer, Graebe, and Liebermann, that in the manufacture of artificial alizarin there are produced three distinct coloring matters--alizarin, iso or anthrapurpurin, and flavopurpurin, the two latter being isomers of purpurin. We may remark that purpurin has not been obtained by direct synthesis. M. de Lalande has produced it by the oxidation of alizarin. Alizarin is derived from monosulphanthraquinonic acid, on melting with the hydrate of potassa or soda. It is a dioxyanthraquinone.

Anthrapurpurin and flavopurpurin are obtained from two isomeric disulphanthraquinonic acids, improperly named isoanthraflavic and anthraflavic acids, which are converted into anthrapurpurin and flavopurpurin by a more profound action of potassa. These two bodies are trioxyanthraquinones.

We call to mind that alizarin dyes reds of a violet tone, free from yellow; roses with a blue cast and beautiful purples. Anthrapurpurin and flavopurpurin differ little from each other, though the shades dyed with the latter are more yellow. The reds produced with these coloring matters have a very bright yellowish reflection, but the roses are too yellow and the purples incline to a dull gray.

Experience with the madder colors shows that a mixture of alizarin and purpurin yields the most beautiful roses in the steam style, but it is not the same in dyeing, where the roses got with fleur de garance have never been equaled.

"Alizarins for reds" all contain more or less of alizarin properly so-called, from 1 to 10 per cent., along with anthrapurpurin and flavopurpurin. This proportion does not affect the tone of the reds obtained further than by preventing them by having too yellow a tone.

The first use of the alizarins for reds was for application of styles, that is colors containing at once the mordant and the coloring matter and fixed upon the cloth by the action of steam. Good steam-reds were easily obtained by using receipts originally designed for extracts of madder (mixtures of alizarin and purpurin). On the other hand, the first attempts at dyeing red grounds and red pieces were not successful. The custom of dyeing up to a brown with fleur and then lightening the shade by a succession of soapings and cleanings had much to do with this failure. Goods, mordanted with alumina and dyed with alizarin for reds up to saturation, never reach the brown tone given by fleur or garancin. This tone is due in great part to the presence of fawn colored matters, which the cleanings and soapings served to destroy or remove. The same operations have also another end--to transform the purpurin into its hydrate, which is brighter and more solid. The shade, in a word, loses in depth and gains in brightness. With alizarins for reds, the case is quite different; they contain no impurities to remove and no bodies which may gain brightness in consequence of chemical changes under the influence of the clearings and soapings. These have only one result, in addition to the formation of a lake of fatty acid, that is to make the shades lose in intensity. The method of subjecting reds got up with alizarin to the same treatment as madder-reds was faulty.

There appeared next a method of dyeing bases upon different principles. The work of M. Schützenberger (1864) speaks of the use of sulpho-conjugated fatty acids for the fixation of aniline colors. In England, for a number of years, dyed-reds had been padded in soap-baths and afterwards steamed to brighten the red. In 1867, Braun and Cordier, of Rouen, exhibited Turkey reds dyed in five days. The pieces were passed through aluminate of soda at 18° B., then through ammonium chloride, washed, dyed with garancin, taken through an oil-bath, dried and steamed for an hour, and were finally cleared in the ordinary manner for Turkey-reds. The oil-bath was prepared by treating olive-oil with nitric acid. This preparation, invented by Hirn, was applied since 1846 by Braun (Braun and Cordier). Since 1849, Gros, Roman, and Marozeau, of Wesserling, printed fine furniture styles by block upon pieces previously taken through sulpholeic acid. When the pieces were steamed and washed the reds and roses were superior to the old dyed reds and roses produced at the cost of many sourings and soapings. Certain makers of aniline colors sold mixtures ready prepared for printing which were known to contain sulpholeic acids. There was thus an idea in the air that sulpholeic acid, under the influence of steam, formed brilliant and solid lakes with coloring matters. These facts detract in nothing from the merit of M. Horace Koechlin, who combined these scattered data into a true discovery. The original process may be summed up under the following heads: Printing or padding with an aluminous mordant, which is fixed and cleaned in the usual manner; dyeing in alizarin for reds with addition of calcium acetate; padding in sulpholeic acid and drying; steaming and soaping. The process was next introduced into England, whence it returned with the following modifications; in place of olive-oil or oleic acid, castor oil was used, as cheaper, and the number of operations was reduced. Castor oil, modified by sulphuric acid, can be introduced at once into the dye-beck, so that the fixation of the coloring matter as the lake of a fatty acid is effected in a single operation. The dyeing was then followed by steaming and soaping.

For red on white grounds and for red grounds, a mordant of red liquor at 5° to 6° B. is printed on, with a little salt of tin or nitro-muriate of tin. It is fixed by oxidation at 30° to 35° C., and dunged with cow-dung and chalk. The pieces are then dyed with 1 part alizarin for reds at 10 per cent., ¼ to ½ oil for reds (containing 50 per cent.), 1-6th part acetate of lime at 15° B., giving an hour at 70° and half an hour at the same heat. Wash, pad in oil (50 to 100 grms. per liter of water), dry on the drum, or better, in the hot flue, and steam for three-quarters to an hour and a half. The padding in oil is needless, if sufficient oil has been used in dyeing, and the pieces may be at once dried and steamed. Wash and soap for three-quarters of an hour at 60°. Give a second soaping if necessary. If there is no fear of soiling the whites, dye at a boil for the last half-hour, which is in part equal to steaming.

Red pieces and yarns may be dyed by the process just given for red grounds; or, prepare in neutral red oil, in the proportion of 150 grms. per liter of water for pieces and 15 kilos for 100 kilos of yarns. For pieces, pad with an ordinary machine with rollers covered with calico. Dry the pieces in the drum, and the yarn in the stove. Steam three-quarters of an hour at 1½ atmosphere. Mordant in pyrolignite of alumina at 10° B., and wash thoroughly. Dye for an hour at 70°, and half an hour longer at the same heat, using for 100 kilos of cloth or yarn 20 kilos alizarin at 10 per cent., 10 kilos acetate of lime at 18° B., and 5 kilos sulpholeic acid. Steam for an hour. Soap for a longer or shorter time, with or without the addition of soda crystals. There may be added to the aluminous mordant a little salt of tin to raise the tone. Lastly, aluminate of soda may be used as a mordant in place of red liquor or sulphate of alumina.

Certain firms employ a so-called continuous process. The pieces are passed into a cistern 6 meters long and fitted with rollers. This dye-bath contains, from 3 to 5 grms. of alizarin per liter of water, and is heated to 98°. The pieces take 5 minutes to traverse this cistern, and, owing to the high temperature and the concentration of the dye liquor, they come out perfectly dyed. Two pieces may even be passed through at once, one above the other. As the dye-bath becomes exhausted, it must be recruited from time to time with fresh quantities of alizarin. The great advantage of this method is that it economizes not merely time but coloring matter.

The quantity of acetate of lime to be employed in dyeing varies with the composition of the mordant and with that of the water. Schlumberger has shown that Turkey-red contains 4 molecules of alumina to 3 of lime. Rosenstiehl has shown that alumina mordants are properly saturated if two equivalents of lime are used for each equivalent of alizarin, if the dyeing is done without oil. These figures require to be modified when the oil is put into the dye beck, as it precipitates the lime. Acetate of lime at 15° B., obtained by saturating acetic acid with chalk and adding a slight excess of acetic acid, contains about ¼ mol. acetate of lime.--*Bulletin de la Société Chimique de Paris.*

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