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Contents:

(Illustrated articles are marked with an asterisk.)

THE UTILIZATION OF IRON PYRITES.

The great number of specimens of this material sent to the office of the SCIENTIFIC AMERICAN for examination suggests a few words as to the characteristics and utilization of a very abundant and useful, but hitherto, in this country, much neglected mineral. That we have not put this important compound of sulphur and iron, which in Europe forms an important article of commerce, to more profitable account can be attributed only to our infancy in the art of manufacturing chemistry. We are still dependent upon foreign sulphur for our oil of vitriol, when stores of iron pyrites, containing not only sulphur but other valuable constituents, lie at our own doors. Pyrites is a term applied to various metallic compounds of sulphur, but the most abundant and well known are those of iron and copper. It is of iron pyrites or sulphide of iron that we propose to speak here, as a mineral worthy attention and study.

It was not until 1835 that the English, who used immense quantities of sulphur in the manufacture of oil of vitriol for the production of carbonate of soda from common salt, suddenly found their supplies of sulphur cut off, by an almost prohibitive duty laid on the exportation of the article by the King of Sicily, from which country most of the crude brimstone of commerce is obtained. The only available substitute was the subject of our article; and it was soon put to such useful account that, in 1861, statistics show that no less than 264,000 tuns were consumed in England. The amount used now must be vastly in excess of this, probably not less than 500,000 tuns per year.

Iron pyrites, though occurring under a variety of forms well known to the mineralogist, is still soon readily recognized, even by the inexperienced, from certain characteristic tests. How many unfortunate dupes has the bronze yellow variety deceived, in the hope that they had struck solid gold, when a few drops of hot nitric acid in the hands of the chemist, or a simple blow pipe test with charcoal, would soon have dispelled their illusion! And yet gold is not always absent. The auriferous pyrites of California, South America, and Siberia, have been profitably worked for gold. The valuable sulphur, however, in the roasting was driven off, as sulphurous acid, into the air to poison the surrounding atmosphere. Improvements are of slow growth. In our search after one valuable material, to which our attention is directed, we are apt to overlook equally valuable ones, until necessity or profit compels us to take account of them. It is but a year or two since the immense copper smelting works at Swansea, Wales, where copper is extracted from copper pyrites, have attempted to utilize the escaping sulphurous acid gas from the roasting ores. These fumes, that for generations settled down upon the surrounding country like a blight, have now been turned into a valuable commercial product.

A very common form of pyrites is that of a bright yellow mineral, which is a true bisulphide, containing iron 46·03 and sulphur 53·97 parts in 100. Iron pyrites is frequently, however, of a dark or bronze color, and sometimes resembles bell metal in its luster, this variety consisting of a mixture of protosulphide and bisulphide of iron. There is also a white variety called white pyrites, which, from its form of crystalization, is termed cockscomb pyrites. Magnetic pyrites also occurs. It is of a deep color and not very abundant. We pass over the numerous compounds formed by the combination and intermixture of other minerals, observing that when the proportion of copper is considerable, the ore is called copper pyrites, and is distinguished by its brass yellow color, the rainbow colors on its surface, and its inferior hardness.

Iron pyrites is so hard that it will strike fire with steel, whence its name, from the Greek word for fire. It was once used in the old fashioned musket, instead of flint, for this purpose. This is an easy and inexpensive test for those who would confound it with gold. Gold is too soft to strike fire in this way, and its weight, bulk for bulk, is four times as much as that of pyrites. In the utilization of iron pyrites for its sulphur, the ore is either roasted in close vessels without access of atmospheric air, when a certain proportion of flowers of sulphur sublimes; or more ordinarily it is burned in the air, for the production of sulphurous acid in the manufacture of oil of vitriol. This is done in peculiarly shaped kilns; and when once ignited, the ore keeps up its own combustion. By this plan of burning, even under the most favorable conditions, two or three per cent of sulphur remains undecomposed. But by pulverizing the ore and roasting on the floor of a reverberatory furnace, not only is all the sulphur expelled, but the residue is in a suitable condition for the extraction of its copper, and the utilization of the remaining red oxide of iron. In England, the pyrites found in the coal beds (and called "brasses"), as well as that from Wicklow in Ireland, is largely burnt for the production of sulphurous acid gas in the manufacture of sulphuric acid. The ore after burning can be utilized as a common red pigment; but where the pyrites contains from one to three per cent of copper, as it frequently does, it is returned after burning to the copper smelter. It is this small proportion of copper that makes iron pyrites so economical a source of sulphur to the oil of vitriol manufacturer, the Spanish pyrites on this account being of late largely imported and used. Ores of this character are utilized at present in England to their fullest extent, their sulphur being first extracted in the manufacture of sulphuric acid, then their copper; and finally the red residue of oxide of iron is sold to the iron manufacturer for smelting. In spite of the abundance of iron pyrites in the United States, we know of but one establishment in this country where it is partially utilized in the manufacture of sulphuric acid.

Another important manufacture, in which pyrites may sometimes be economically used, is that of sulphate of iron or copperas. When pyrites is exposed to the influence of air and moisture, it undergoes decomposition. The two constituents of the pyrites, sulphur and iron, absorb oxygen, becoming converted respectively into sulphuric acid and oxide of iron; these from their chemical affinity unite and form sulphate of iron or copperas. In the manufacture of copperas, the ore is first stacked in large heaps on a clay floor or other waterproof foundation. It is then roasted to hasten its decomposition, and afterwards moistened with water from time to time as required. The resulting solution of sulphate of iron is then caught in suitable vessels, concentrated, and crystalized. In the South Lancashire district in England, over 80 tuns of copperas per week are thus produced; and in Stafford, Vt., copperas has been made in this way for at least half a century.

We have spoken of the "brasses," or yellow pyrites of the coal measures. These are readily decomposable; and during decomposition, so much heat is sometimes liberated as to inflame the remaining pyrites and finally set the coal on fire. When this happens, the workmen are compelled, at great expense and loss of time, to flood the mine to put a stop to the conflagration. The water pumped from coal mines containing iron pyrites is sometimes so strongly charged with the acid sulphate of iron, that the iron pumps used for its removal are rapidly corroded.

There are undoubtedly many localities in this country where the pyrites is sufficiently abundant and readily decomposable for the economical manufacture of copperas, a salt which is largely used in dyeing, as a disinfectant, and for the manufacture of ink and Prussian blue. Where the pyrites contains a small proportion of copper, it may be more economically utilized, in the way already shown, for the production of sulphuric acid.

THE INFLUENCE OF CARGOES OF MACHINERY AND HARDWARE ON SHIPS' COMPASSES.

In order to determine the local deviation of a ship's compass, due to the materials entering into the vessel's composition affecting the needle, it is usual, before proceeding to sea for the first time and at certain intervals thereafter, to swing ship and compare the indications of a standard compass, located in a position out of the sphere of attraction, with those of the ordinary steering instruments in the binnacle. By this means a correction for every point is found, which must be allowed for in steering a course per the binnacle compass.

While there is little question but that every captain of a sea-going steamer is in possession of the important data thus obtained, there is in our minds considerable doubt whether a similar allowance is made for the nature and storage of the cargo. A hold full of hardware would undoubtedly affect the compasses, and cases, of arms, for example, or any other articles of iron or steel, carelessly left near the binnacle, might throw the ship miles off her course and be productive of just such a disaster as that of the Atlantic. The captain of an English vessel, the Duke of Argyll, steaming between Liverpool and Dublin, a foreign contemporary informs us, found that a box containing six sabres and three scabbards, placed at a distance of 10 feet away, exercised a sensible influence on the needle, which, when the disturbing cause was removed, oscillated from side to side for fully five minutes before it resumed its normal position. Another instance is on record of a ship being thrown some distance from her proper position through the careless placing under the compasses of a case containing a couple of small sewing machines and a few packets of needles.

These instances show that serious consequences may be due to indiscriminate stowage of cargo composed of objects of iron or steel. In fact every shipper of hardware or machinery, or passenger having in his possession such articles, should, for his individual as well as for the general interest., advise the captain and, besides, have the cases conspicuously marked as to contents, so that every precaution may be taken to avoid their influence upon the compass. It can hardly be expected that a merchant vessel will swing ship every time that she goes to sea, but at least the danger of a guide, upon which the safety of the vessel depends, becoming unreliable will be materially lessened by a careful and intelligent disposition of the metallic portion of the cargo.

NEW IRON ALLOYS.

A new process of manufacture of alloys of iron with manganese, titanium, tungsten, and silicon, and of the agglomeration of these substances for treatment in a special furnace and in movable crucibles, has recently been patented in Belgium.

Up to the present time, as our readers are doubtless aware, but one of these alloys has been to any extent industrially manufactured and employed. This is ferro manganese, which contains twenty-five to thirty per cent of manganese, with from 70 to 75 per cent iron and from 5 to 6 per cent carbon. In France and Germany, this alloy has attained some importance, and is stated to admit of the manufacture of certain qualities of cast iron with a regularity and surety not given by any other process. It has heretofore been produced either by the Prieger crucible system or by the Henderson process, both being based upon the simultaneous reduction in presence of finely divided charcoal of a mixture of the ores, pulverized, of iron and manganese. The presence of iron in the mixture determines the complete reduction of the oxide of manganese, and is indispensable to such reduction, a fact evidenced by the difficulty always encountered in obtaining metallic manganese during laboratory researches, and by the large expenditure of time and fuel usually required in effecting the reduction of the oxide. On account of the pulverulent state of the mixture, and of the poverty of the batch, which should contain an excess of charcoal, these two processes are able to produce in a given apparatus but small quantities daily of the alloy, and with an enormous consumption of fuel. The difficulty seems to have been to find a system which would answer all industrial requirements, work continuously, effect the reduction of the oxides successively and not simultaneously, and finally cause their complete fusion. A vertical apparatus, analogous to a high blast furnace, it would appear, might answer the requirements, and it is stated that in certain localities, where ore has been found containing the proper proportion of iron and manganese, two smeltings have been produced, containing 18 per cent of the last mentioned metal. Unfortunately, however, such ores are very rare, for it is a necessity that they should be almost absolutely free from silex. Moreover, it is difficult to pass into a high furnace material reduced to a dust. The operation is productive of accidents, while it is hardly possible, subsequently, to preserve a regular working. Beyond this, the interior surface of the apparatus, incessantly in contact with the semi-reduced pulverized oxides which the blast drives into the very joints, becomes attacked with great rapidity.

The new process to which we refer in our initial paragraph and for the following description of which we are indebted to the *Chronique de l'Industrie*, appears to be based on a system of agglomeration, which permits of the introduction of the oxides no longer in a state of powder, but in the form of small bricks or lumps, containing the elements of the alloy to be produced. Many attempts, it may here be remarked, have already been made to agglomerate the rubbish of iron ore, which, in certain districts, exists in profusion, and which in its natural state is useless: but none have given satisfactory results. Lime, pitch, and fatty earth, have been successively employed, forming briquettes, which, though appearing of sufficient solidity when cold, disaggregated completely in the fire, or contained vitrifiable elements in such quantities that the ore became impoverished to an inadmissible degree. From the description of the new process, we learn that, if metal in granulated form, in the shape of filings, of iron or steel turnings, of spongy iron coarsely pulverized, or of any other *débris* of iron or steel in an analogous state of division, be mixed with ores containing manganese, tungsten, titanium, or a combination of these metals, or with quartz: the ores or quartz being finely pulverized and introduced in suitable proportions for the alloy: if this mixture be completely and regularly moistened with an ammoniacal solution, or with water slightly acidulated, and finally compressed in a mold of iron, a strong development of heat is produced; and at the end of several hours, if the mold be opened, a very hard compact mass will be found, which can be broken by the hammer into fragments of desired size. These pieces resist red heat perfectly, and do not commence to disaggregate until the point of fusion of pig iron. Their proper treatment in a high blast furnace affords the means, it is stated, of obtaining alloys containing iron and manganese, in all proportions ranging from 25 to 75 per cent of the latter metal, also combinations of iron and silicon, up to 25 per cent of silicon, and finally alloys of iron and tungsten or titanium, or even triple alloys of the different metals. These results are, however, obtained only at high temperatures, with a hot blast at strong pressure, and it is stated that the apparatus ordinarily rapidly deteriorates at its lower portion. To avoid this last mentioned defect, a furnace of especial construction is employed. The shaft is formed of refractory brick as hard as possible and

in which the aluminous element predominates. The hearth is of lime, magnesia or pure alumina, and the crucible is of carbon lime or magnesia. The latter portion is made in a single piece, by molding a mixture of pure graphite, gas carbon, or pure coke, in a cylindrical shaft or mold of bloom plate, and raising the whole in temperature to nearly a dark red heat for some hours. A very hard compact mass without fissures or joints is thus obtained.

The hearth is enclosed in a conical sheet iron shaft, secured by dowels to the pig iron plate which carries the tunnel. The crucible is movable, and simply rests against the lower part of the hearth. It is held in place by small blocks. The entire arrangement is such that the working parts of the apparatus can be easily renewed or repaired in a short time. The blast is heated to at least 726 Fah. and its pressure equals from 5·07 to 5·85 inches of mercury.

AUGUSTE DE LA RIVE.

This distinguished philosopher, who was among the foremost of European *savans* for more than half a century, died on the 29th of November, at Marseilles, France. He was on his way to one of the numerous health resorts of the South of France, but was unable to reach it.

Among De la Rive's earliest investigations are to be found some important researches on the specific heat of many simple and compound gases, and here commenced his fame, and his influence in the Academy of Geneva, of which he was, up to the day of his death, the guiding spirit. The science of electricity was scarcely in existence at this time (1825), and its rapid development during the past 50 years has received much impulse from the labors of De la Rive, whose zeal in investigation was indomitable. In 1840, he discovered the value of the voltaic current in depositing gold on silver and brass, and at once published it, declining to make any profit from the invention. For this, the French Institute awarded him their premium of $600.

De la Rive was a man of almost universal culture, and his society was sought by literary men, politicians, and artists, as well as by his fellow scientists. The Swiss Confederation intrusted him with the delicate mission of laying before the British Government the danger that Switzerland was exposed, to by the absorption of Savoy and Nice into France, and he had the satisfaction of obtaining from Lord Palmerston a declaration that any attempt on the part of France against the independence of Switzerland or Belgium would be considered a *casus belli* by England.

The labors of De la Rive were universally recognized as of the highest value, and honors and distinctions from scientific bodies in all parts of the world were conferred upon him. He died in the 73d year of his age.

DEATH IN THE SCHOOL ROOM.

Despite the frequent casualties due to imperfect ventilation, together with the generation of noxious gases in largely populated buildings, though assisted by the oft repeated counsels of the best sanitary authorities as to the proper mode of remedying the evil, our progress in learning how to afford a constant supply of pure fresh air is, at best, sadly discouraging. The New York *World*, with commendable enterprise, has recently employed Dr. Endemann, of the Board of Health of this city, to make a careful chemical examination of the condition of the atmosphere in our public schools; and the results of that gentleman's investigations, as published with much detail in the above mentioned journal point to a state of affairs that is simply disgraceful.

Graham and Liebig have pointed out that the mean amount of oxygen in the atmosphere is 20·9 volumes per cent, leaving a balance of 79·1 nitrogen, carbonic acid, and other constituents. The normal quantity of carbonic acid gas is, however, very small, and is estimated by De Saussure at 4 parts in 10,000. Dr. Parkes considers that an increase of this proportion to 6 parts in 10,000, or 0·06 of 1 per cent, is the highest permissible impurity. In analyzing the samples of air, Dr. Endemann used Pettenkoffer's method, by which the air is introduced into a glass globe, together with a solution of caustic baryta of definite strength. The alkalinity of the baryta solution is diminished in proportion to the amount of carbonate of baryta formed, and will be neutralized by a proportionally less quantity of a given solution of oxalic acid, thus furnishing the elements of an accurate calculation of the amount of carbonic acid in the air contained in the globe. A measured amount of lime water of known strength may be used instead of the caustic baryta solution. The effect of the carbonic acid is then to neutralize and precipitate a quantity of lime in the form of chalk, and the oxalic acid determines the proportion of lime subsequently remaining. The difference in the quantity of lime before and after the action upon the air enables the operator to calculate the existing ratio of carbonic acid.

Carbonic acid is the product of perfect combustion and of the breathing of animals, the oxygen in the latter case uniting with carbon in the system; and the air expired contains about 4½ per cent of carbonic acid gas. This, however, in open atmosphere, soon diffuses itself, but, if confined in circumscribed quarters, contaminates the air to such an extent that, if atmosphere containing one two-hundredth part of it be breathed, headache and lassitude result. Such a proportion is, however, far from fatal, for Berzelius points out that five or six per cent may be inhaled with safety, and that life may continue for some time in an atmosphere containing thirty per cent. This latter assertion, we imagine, must be based on an extreme case, as it is generally conceded that twenty-five per cent of carbonic acid is sufficient to cause speedy death. Dr. Endemann, in his report, exemplifies the mortal effects of the gas in a statement that children breathe about fourteen cubic feet of air per hour, and this air, when exhaled, will contain 430 times the normal amount of carbonic acid. If 100 persons be placed in a room, say 18 feet square by 11 feet high, and the doors and windows be hermetically closed, so that there could be no circulation, in about two hours and a half all the air would be inhaled and probably not a soul would be living.

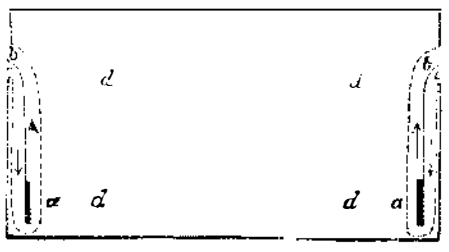
Space necessarily forbids our following the carefully prepared details of the report before us, but the citation of a few cases will serve to show the flagrant neglect which must characterize the sanitary regulations of our schools:

(1) Rooms 18 by 16 feet: 42 scholars: temperature, 62° Fah.; carbonic acid in 10,000 parts, 26·1, or 6·6 times the normal amount. The air was described by the inmates as generally oppressive. (2) Large class room, 20x18 feet: Odor very foul; 47 scholars; 4 times the normal amount. (3) Class room on top floor: 65° temperature; air described as constantly bad, and very correctly, as analysis showed 8·1 times the normal quantity of carbonic acid. In the next two tests, this proportion is 7·5 and 5 times.

The annexed engraving is a specimen of the heating and ventilating arrangement in the well known 12th street school, an establishment accommodating 1,200 female scholars. *a* is the register, and *b* the ventilator. The heat, entering, roasts

the back of the teacher at *d*, ascends, and immediately escapes at *b*, or, in case the window is open, diverges into another current, *p*. The cold, heavy carbonic gas is, as is evident, totally unaffected by the draft, and settles down upon the children at *e*. Mr. Lewis W. Leeds made a report regarding this school some time since, which, for some occult reason, the Board of Education saw fit to suppress. He pointed out the difficulties above indicated, and also explained a neat arrangement of the janitors, in converting the fresh air ducts to the furnaces into hen roosts, partitioning the same off, so that the air supply was obstructed; but a copious odor of poultry was added to the hot current. "Fowl" air, he very truly remarks.

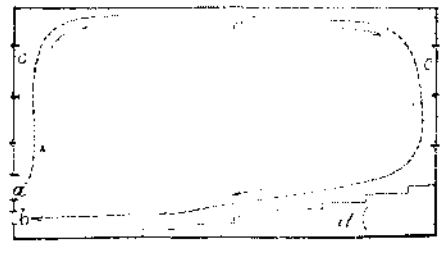
Example 6 consists in analyses made in a room heated by steam; teacher and children all complaining. The temperature was 60°, and 8·3 times the normal proportion of carbonic acid was indicated. Passing over succeeding tests, none of which show a larger percentage of carbonic acid than last mentioned, we notice repeated cases of the most dense ignorance displayed in the steam heating arrangement. In one school the ventilators were shut, choked by rust, and the janitor had no conception of their use. In another the steam heaters were arranged after the fashion indicated in the next



engraving. The current of air from the heater, *a*, escapes through the opened window, while the cold air from the latter pours down. There is a constant circulation, as indicated by the arrows, at the sides of the room, while the center of the apartment becomes packed with foul air.

There is no necessity of entering into further minutiæ. In this city there are 59 grammar schools, 42 primary schools, and 6 schools for colored children, and the number of pupils thus subject to the dangers we have noted is estimated at from 80,000 to 100,000. There is unquestionably a decided need for simple and efficacious plans of ventilation, which may be promptly put in practice in these institutions at no very large expense. Dr. Endemann suggests the following system:

Here the warm fresh air, flowing in at the register, *a*,



ascends to the top of the room. The windows being closed, it cools gradually and descends, returning to the ventilator, which is either below or on a level with the register, where it is drawn off and escapes through the flue.

The New York *World* has done good work in thus exposing the shameful condition of our schools, and parents would do well to profit by the warning. It supplies the explanation of many a pale face and aching head, if not of severer maladies, engendered by a system of slow poisoning. Other cities may take the hint, and investigate their own educational buildings. To architects and builders generally, the subject expressly addresses itself for a speedy and efficient solution.

TO OUR FRIENDS.

In dealing with our legions of friends, it is our earnest desire to give satisfaction to every one of them. But should any suppose that we have overlooked their requests or slighted their interests, we hope they will at all times promptly inform us. Postal cards only cost a penny. Speak plainly, and do not hesitate to complain.

Our mail writers and folders are under special injunctions to write our subscribers' names upon the envelopes legibly, and fold each paper neatly. We shall be glad to be informed if anybody receives slovenly work from this office.

At the beginning of the year, many thousands of subscriptions are renewed, new clubs formed, etc. If any person fails to receive the paper, or any premium to which he is entitled, we will thank him to inform us promptly.

If, by any chance, any editor or publisher, who by any agreement is to receive our paper, should fail to receive it, we shall be glad to be informed.

Persons who have written to us upon business or sent enquiries for the paper which have not been answered, are requested to repeat their enquiries. Letters sometimes fail to reach us. Be particular to mention the State in which you live. In some cases we are perplexed to know where to direct, when no State is given and there are many post offices of the same name.

SCIENTIFIC AND PRACTICAL INFORMATION.

FOG SICKNESS AMONG ENGLISH CATTLE.

The recent heavy fogs about London and its vicinity have been productive of an unusually large outbreak of sickness among the cattle gathered at the Smithfield Club show. The sufferings of the animals are described as very great, and are so clearly traced to the peculiar state of the weather as to excite apprehension that some similar malady may attack the stock on this side of the water, if the dense mists, which have prevailed to such an extraordinary degree during the present winter, continue. The *Field* says that, on the third day of the show, which opened with every appearance of a successful exhibition, and with a fine variety of prize cattle, ninety of the animals were removed, seemingly choking, and it was found necessary to slaughter fifty immediately. The illness was not confined to the single locality, but affected the horned cattle in the markets and in the suburbs; so that it was not, as has been suggested, due to foul air or lack of ventilation in the Smithfield Club building. Sheep and pigs, moreover, were not affected. The treatment used was an abundant supply of pure air and a sedative tincture of aconite. The sickness lasted for about five days, until the dissipation of the fog.

NEW OBSERVATIONS OF STELLAR MOTION.

Dr. H. Vogel, at the new observatory at Rothkamp, near Kiel, Germany, has recently made some researches into the movements of certain stars with relation to the earth by observing the position of the rays of their spectra. The stars thus examined are α *Lyræ* and α *Aquilæ*. It appears that α *Lyræ* is approaching the sun at the rate of 52 miles per second, a result which accords with previous observations made by Huggins, in which the speed was estimated at between 45 and 54 miles. α *Aquilæ* is moving in similar direction at the rate of 48 miles per second. Dr. Vogel applied his method to the constellation of *Orion* some time ago, and determined that it receded from the sun at a speed of about 16 miles per second.

DECORATING WOOD BY PRINTING.

Mr. Thomas Whitburn, at a recent meeting of the English Society of Arts, described a process, recently patented by him, adapted to express, on flat surfaces of wood, effects of light figures on a dark ground, or of dark figures on a light ground, or of figures light and dark in parts on a ground intermediate in shade. The designs or patterns are engraved in the ordinary way on box wood, and, from the blocks, the wood is imprinted on a common hand printing press with printer's ink. The process is capable of being used with two or more colors, and is designed for the ornamentation of door panels, furniture, etc.

NEW PHOTOGRAPHIC PROCESS.

We have heretofore mentioned a recent improvement in dry plate photography which consists in using gelatin instead of the ordinary collodion. The nitrate of silver, for sensitizing the gelatin, is mixed with the gelatin solution. The only drawback to this new process was the fact that the gelatin solutions could not be long preserved, especially in warm weather. This difficulty has been lately overcome by Mr. Burgess of England, who prepares the sensitive gelatin solution in any quantity that may be desired, and, after preparation, desiccates or dries the same by spreading the solution on glass plates. The dried film is then broken up into small bits and packed away in dried condition for use. Thus prepared, it will always keep good and only requires to be dissolved in water, to form an excellent sensitized solution.

THE ALIGNMENT OF THE HOOSAC TUNNEL.—Mr. Charles Fosdick, of Fitchburg, Mass., writes to say that the credit of the calculations in boring the Hoosac tunnel and the almost perfect alignment is due to Mr. Frank D. Fisher, the first assistant of Mr. B. D. Frost, the chief engineer. Mr. Fisher is a native of Massachusetts, and was educated at the Institute of Technology in Boston.