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THE PHOSPHATES OF PICARDY.

It may be said that the agricultural importance of any country is exactly measured by the quantity of phosphate of lime that it consumes, and so the activity that is displayed in collecting this material is truly feverish. Distance, difficulties in transportation, and the most deep-rooted prejudices are nothing before the prospect of obtaining it. Witness the English ransacking the hypogea of Egypt, and tearing the bandages from mummies in order to make fertilizing material for their fields. Witness the facility with which thousands of Chinese were immolated in the murderous exploitation of the guano of the Chincha Islands. Witness the short time that it has taken to exhaust the rich deposits of Quercy, the huge efforts to render the apatite of Canada and Estramadura assimilable, and the feeling with which we have recently learned of the discovery of phosphate in the vicinity of Mons by Mr. Cornet, and in fifty of our departments by Mr. De Molon.

The reason is that phosphate of lime, one of the constituent elements of our bones, is an incomparable fertilizer. It presence in the soil, even in small quantity, often suffices to profoundly modify the character of the crop. Thus, to cite but a single example, the sugar manufacturers of the Department of the North, observing a progressive and rapid diminution in the saccharimetric standard of their beets, found it only necessary to apply to the soil the phosphate of lime that had been gradually lost by continuous culture, in order to restore to the beet the valuable juice sought for in it.

This fact, and many others that might be cited in addition, allow us to understand how it is that every discovery of a deposit of phosphate is of a nature to excite a population of interested parties.

This is just what has recently occurred over an area of six by two and a half miles to the south of Doullens (Somme), and especially at Orville, Blauval, Beauquesne, Terramesnil, and Candas. The presence underground, in the inequalities of the chalk, of a deposit of phosphate of lime has revolutionized the country. Nothing else is thought of but phosphate, and everything gravitates around that alone. A true fever reigns, and one almost on a par with that which broke out on the discovery of gold in California and Australia.

As you pass along the road, the peasants, on observing your bag and geological hammer, whisper among themselves: "He is going to the phosphates." And they look at you with an anxious eye. An old woman asks you if she does not owe you something, making believe that she takes you for a tax gatherer, and for the sole purpose of getting you into conversation and learning your intentions.

In the field, groups of two or three laborers are probing the earth, that is to say, are boring 18, 24, 30, or 36 ft. holes by means of a hollow rod 1½ in. in diameter, in order to ascertain its nature. In case of success, there are exclamations of joy, for the land will sell for twenty or thirty times as much as it was worth the day before. Some specialists from Ardennes and from Belgium bought several million dollars' worth of land without delay, and are beginning to work it. As in all mining countries, sudden fortunes are made, and reasons dethroned. A small merchant had just bought a modest house for $400, when, phosphate having been discovered in the ground, his property was forthwith purchased from him for $13,000. The poor man lost his head over it, and promenaded the streets dressed like a woman. His joy was so noisy that the first owner of the house intervened. The sale is so recent that it may be canceled, and as $13,000 is worth more than $400, a lawsuit is to be instituted.

In one of the villages a field of phosphate is separated from the cemetery only by a narrow footpath. There was nothing to show that there was an interruption in the deposits, and the excavators made an offer to the Common Council to purchase the cemetery. Respect for ancestors who were to be disturbed might, *a priori*, have rendered the conclusion of the bargain difficult. But the true objections had another source. If there was a desire to buy the land, it was because it contained phosphate, and it was, therefore, worth much more than the sum offered. It was, therefore, necessary to have an adjudication. But, in order to get a basis for the price, borings had to be made. The soil was examined, and nothing found in it. The village keeps its cemetery. The discovery of this valuable substance, worth $14 per ton, that is to say, much more than coal, has not only turned the heads of many people bent on making a fortune, but has greatly excited the curiosity of geologists, and it is for this reason that, in the agreeable society of Messrs. E. Derennes and H. Boursault, I took a trip to Doullens. What I saw there has seemed to me of sufficient interest to be described to the readers of this journal. On my arrival, I met some very kind persons, who gave me all the information desirable, and in their company I visited the deposits. With us went a dog, which was naturally named Phosphate. We were on the nearly level plateau of Picardy, which is intersected by numerous valleys, and the soil of which consists of a thick clay, very pebbly toward the bottom, and which bears the local name of *bief*. It is the same formation that is elsewhere called silicious clay, or earth overlying the chalk. The latter, in fact, forms the subsoil, and prospecting wells, six feet in diameter, permit its relations to the superposed masses to be seen. For example, one of these wells shows 14¾ ft. of *bief* covered with a fertile clay allied to loess, and then 15 ft. of phosphate with chalk beneath.

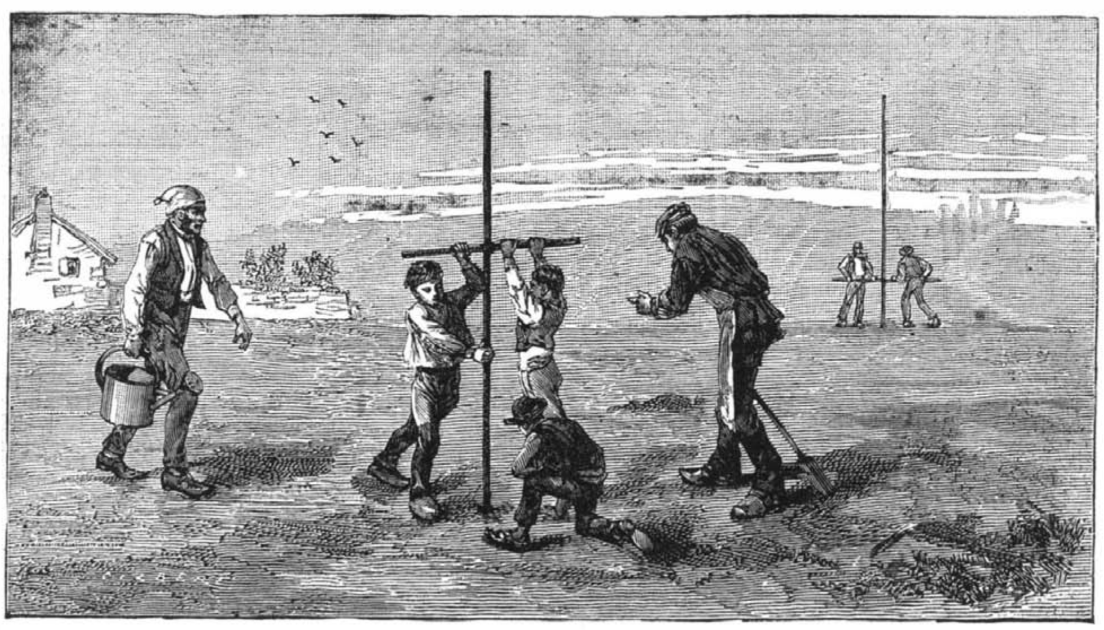


FIG. 1.—PROSPECTING FOR PHOSPHATES IN PICARDY.

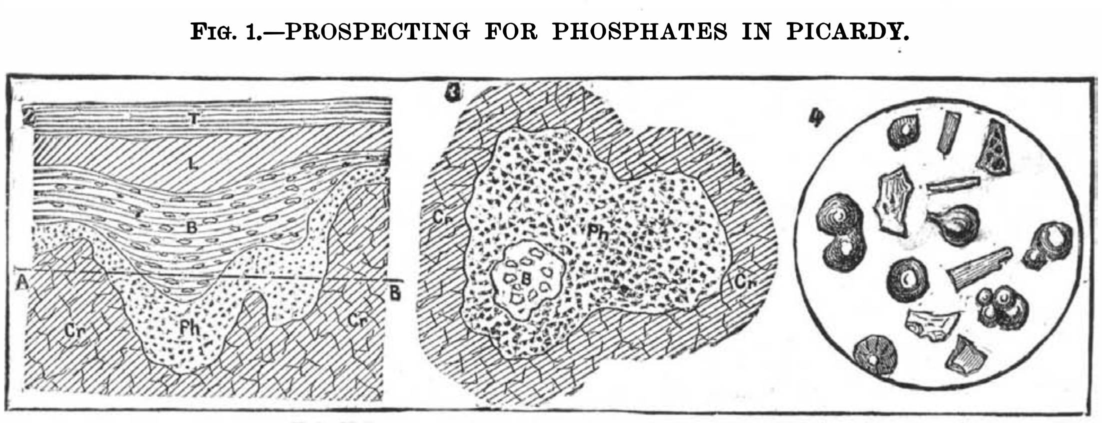


FIG. 2.—Vertical Section of the Beauval Phosphate Deposit. Cr, chalk; Ph, phosphatic sand; B, silicious clay; L, clay; T, humus. FIG. 3.—Horizontal Section in the Direction A B of the preceding figure, showing an argillaceous cylinder, B, in the axis of a well filled with phosphate, Ph. FIG. 4.—Grains of Beauval Phosphatic Sand, magnified 125 diameters.

These wells, however, although excellent for revealing the presence of the substance sought, give but very incomplete geological data, and it is in broader exploitations that we may hope to clear up all the questions relative to this subject. We then see (Fig. 2) that the upper limit of the chalk, instead of being nearly horizontal, like that of the earth at the surface, is extraordinarily irregular. It contains pockets or wells, sometimes many feet in depth, which have been filled up with various substances. These pockets are of very variable form, and in one of the exploitations there were found two in the form of reversed cones, from 10 ft. to 13 ft. in diameter, separated by only 8 in. or 10 in. of chalk. The internal wall of the pockets is polished like that of pot-holes and many natural wells, thus proving a slow dissolving of the calcareous rock by a corrosive liquid that could have been nothing but water charged with carbonic acid.

The materials that fill these cavities in the chalk are arranged in strict order, and on the secondary rock there is a coating—sometimes very thick—of phosphate of lime. In the interior of the phosphatic sheath, whose upper surface, although less irregular, is depressed, we find clay. This latter, which is colored with oxide of iron, sometimes contains, through contact with the phosphorite sand, a quantity of phosphate amounting, as I have been told, to as much as thirty per cent. We likewise find therein black patches of oxide of manganese that bring into clear relief the form of the surface of junction. This clay, which recalls lithomarge, and which would not be distinguished from the filling-in of the narrower portions of all natural wells, constitutes a cup less concave than the preceding, and is sunk in the phosphate, which is itself sunk in the chalk. Above is seen the true silicious clay, which, as before stated, has nearly leveled off the irregularities of the subjacent masses, and which supports the superficial clays and humus.

At certain points, the mass overlying the chalk, in the axis of the wells, is about fifty feet in thickness. From this structure, it will be seen that a horizontal section (Fig. 3), extended to a proper height in the deposit, will give the interior of the cretaceous wall a mass of phosphate enveloping a sort of clayey axis.

I have said that, toward its margin, the clay may contain a notable proportion of phosphorite. The excavated chalk is filled with small grains of the same nature. Now, it is perfectly certain that the phosphate has accumulated in the wells in the chalk in measure as these have been hollowed out under the influence of corrosive agents. Such an origin, by way of subaerial denudation, is identical with that of the silicious clay, and supposes no reaction different from that of which we are daily witness.

As regards this, it seems to me that the non-phosphatic chalky masses, rich in silex, whence the *bief* is derived, were at Beauval originally superposed upon the phosphated chalky strata.

Denudation, through infiltration of carbonated water, has at first been effected at their expense; then the phosphated strata have been attacked in their turn, and the phosphate has remained as a residuum after the dissolving of the lime. And we must understand the sliding of the argillaceous cylinder into the axis of the phosphate wells to be a consequence of this successive corrosion, just as we understand the sliding of the pebble beds into the axis of the natural wells in the Ivry limestone.

One circumstance that adds much interest to the mode of formation of the phosphate at Beauval is that it is not exceptional. We find it, feature for feature, in several localities in the vicinity of Mons (Belgium) that I had an opportunity of visiting a few years ago under the guidance of Mr. Cornet. In Picardy, as in Belgium, the phosphatic material is found in the form of a very fine sand of a light yellow color. Under the microscope, we find that the grains of phosphorite frequently reproduce the most characteristic forms of concretionary products, and particularly of silicious ones.

These are often nearly perfect globules (Fig. 4) with a smooth surface, sometimes twin, in the form of gourds, sometimes provided with a little tail, and showing concentric layers, in section. The Beauval phosphate, however, differs from that of Mons in the almost entire absence of fragments of shells, which are very numerous in the latter.

I have not been able to carry the stratigraphical study very far, but it may be possible that the phosphatic chalk of Beauval is a little more ancient than that of Belgium. According to Mr. Cornet, the latter is more recent than the chalk of Spienne, which itself rests upon the chalk of Nouvelles, a cotemporary of our Meudon strata. Now, at Beauval there is an abundance of *Belemnitella quadrata*, that is to say, a fossil that antedates *B. mucronata*, and which is found only at the level of Beynes. It is evident, moreover, that the phosphate is much more recent than the rock that contains it.—*S. Meunier, in La Nature.*

To find if white lead has been adulterated by permanent white or sulphate of baryta—the commonest adulterant—the admixture may be recognized by boiling a small quantity of it in a glass test tube with nitric acid diluted with an equal measure of water. The white lead dissolves, but the baryta remains as a white residue. This should be allowed to settle, the clear liquid poured off, and the deposit again treated with nitric acid and then boiled with water.

HELIOGRAPHY, OR THE ACTINIC COPYING OF ENGINEERING DRAWINGS.*

By Mr. B. H. THWAITE, Assoc. M. I. C. E.

THE advantages of rapidity and fidelity of reproduction possessed by the actinic copying method are already well known; but the following notes on the most modern practice may be interesting to engineers. Sir John Herschel, who was probably the first to employ photographic printing for purely scientific purposes, used a cyanotype process for reproducing his astronomical tables. In 1840, a paper was submitted to the Institution by Mr. Alexander Gordon, entitled "Photography as applicable to Engineering," in which Mr. Gordon described Daguerre's discovery, pointing out the advantages it offered to the engineering profession, and recommending the silver printing as a ready means of obtaining duplicates of drawings. Engineers did not, however, employ heliography to any great extent until the ferro-prussiate, or cyanotype, commonly called the blue copy, process was introduced, when the advantages of cyanotype heliography became manifest; and, in some instances, the simple apparatus required for this method has been extended into complete photographic ateliers. The Midland Railway Company; Krupp, of Essen; Sir W. Armstrong & Co., of Newcastle; and Siemens & Halske, of Berlin, have photographic departments. The latter firm, in its Berlin establishment, employs a powerful electric arc-light of 6,000 candles, around which the printing frames are placed, and both the platinotype and Pellet processes have given successful results with the arc-light.

The heliographic apparatus includes tracing paper or cloth printing frames, a developing bath, non-actinic arrangements, and cases for storing paper. Thin bluish tracing paper is the best; the more translucent it is, and the stronger, the better. After the tracing has been made, it should be preserved from light, as exposure to light gradually renders tracing paper more opaque. The tracing should never be folded, but kept perfectly flat or rolled. Drawings on ordinary drawing paper, or from illustrated papers, can be copied if they are exposed to the light sufficiently long, the duration of exposure depending on the thickness or transparency of the paper. When the drawing only shows half the section of the figure to be traced, the full section can be shown by tracing the other half on the back of the tracing paper. The sun copying reproduction is precisely the same as if the tracing had only been made on one side, but all the writing and dimension should be on the front side. Translucent drawing parchment paper, specially prepared for sun copying processes, can now be obtained. The dimension lines for the ferro-prussiate or cyanotype negative should either be dotted or ruled in Indian ink, chrome yellow, or raw sienna; or if in Prussian blue or carmine, the colors should be made more opaque by a slight admixture of flake or Chinese white. In copying by the ferro-prussiate or cyanotype processes, the sectional parts of the figure should be cross-hatched, or the sectional parts can be colored with shades slightly less opaque than the linear portions, by the addition of an opaque color, such as Chinese white; and as these sectional parts of the print are reproduced almost white, they can be colored with the usual conventional colors, which could hardly be done on a blue ground. The Pellet and Shawcross methods allow of the ordinary conventional colors being used without this preliminary preparation. The best Indian ink should be employed, its opacity being increased by the addition of gamboge or chrome yellow.

The printing frame is the most important part of the apparatus, as upon its merits depends much of the success, both as regards accuracy and legibility. If the tracing and the sensitized paper are not brought into close contact with each other, the actinic rays pass under the lines of the drawing, which are thus either obliterated or contorted. The pressure should be uniformly distributed, to bring the sensitive and tracing papers into close contact, as any local pressure produces irregularities and false impressions, causing wrinkles in the tracing paper, the shadows of which are reproduced. In order to test the shrinkage of the paper, the scales should be drawn on the tracing in two directions, at right angles. The shrinkage of strong Pellet or cyanotype paper is equal to 0·005. The form of frame is very simple. The glass should be ¼ in. plate, free from blemishes, and the author has used 26 oz. glass for small frames. A piece of soft felt, ½ in. thick, the full size of the frames, should be used to equalize the pressure, or a piece of folded flannel will serve the purpose admirably, and it is well to use India-rubber sheets, sewn to the edges of the flannel or felt. The most useful sizes for the printing frame are 12 by 14, 19 by 26 for royal, 22 by 30 for imperial, 30 by 43 for double elephant, and 40 by 56 in.

The method devised by the author for hanging the printing frames is so constructed that the printing frame can be inclined at any angle. This frame is adapted for offices in which space is limited, and, in combination with the author's arrangement of developing bath, forms all the apparatus necessary for the Herschel, cyanotype, and Shawcross processes. Where diffused light alone reaches the office, owing to the obstruction of neighboring buildings, reflecting frames can be used, or the printing frame may be hoisted to the roof fanlight by pulleys. The tracing is placed with its figured face next the glass, and the sensitized paper, with its prepared face next to the tracing, is carefully and uniformly pressed into contact with it. The felt is next laid upon the paper, in such a way as not to disturb the position of the tracing or the sensitized paper. The back board is then placed on the felt, the clamping-bars are fixed in position, and the face of the frame is exposed to the sun at such an angle as to be as nearly as possible at right angles to the solar rays. There should not be any obstacle, such as window mullions, etc., intervening between the printing frame and the source of light, as any partial obstruction of the rays would produce an imperfect copy. Where practicable, the printing frame should be exposed in the open air to the full rays of the sun or to the brightest part of the sky, preferably placing the face of the frame flat, so as to get the direct rays from the zenith, and with no wall near it to obstruct the light. If such a wall exists, it should be colored white, to reflect as much of the actinic light as possible. If this is not possible, the frame should be exposed for half the time of exposure turned in one direction, and then reversed end for end for the remainder. Instead of springs or clamps on the printing frame, use may be made of Street's copying frames, with an air cushion inflated by simply blowing, and exerting a uniform pressure over the whole surface of the frame. The sensitive paper should be taken from its case in non-actinic light. This is especially important with papers sensitized by processes Nos. 3, 4, 5, and 6, described further on.

The author has employed yellow window blinds, which have proved sufficiently effective in obstructing actinic light; and amber colored glass may be used, or ordinary windows can be converted into non-actinic ones by being covered with ruby, yellow, or amber colored glacial paper. The light of any office can thus be made non-actinic at a slight expense. The author sensitizes the paper in the evening, using a ruby lantern. When the paper has been prepared by the cyanotype processes or the gallic acid process, non-actinic arrangements are superfluous, as these papers may be freely handled in the diffused light of an office for the short time required to cut and place the sensitized paper in the printing frame. The developing bath should be slightly larger than the paper to be treated. For acid solutions, the bath should be of earthenware, papier-mache, vulcanite, or enameled iron; but for most of the solutions mentioned in this paper, the bath may be of zinc, or of wood lined with gutta-percha, or sheet lead.

For the Pellet process, two trays lined with gutta-percha, and one zinc tray, will be required. A copious supply of water to the bath, from a 1 in. rubber tube attached to a water tap, will be found a great advantage. The print, on its removal from the frame, should be rapidly transferred to the bath, and after being immersed in pure water until it is completely developed, should be withdrawn and hung up on a line, or on glass rods with clips, until the water has drained off, and blotting paper will then effectually remove the remaining moisture. A wooden bath may be employed if, when perfectly dry, it is treated with a varnish of ½ lb. of common brown resin and 2 oz. of beeswax. The developing bath designed by the author is well suited for offices where space is limited, as it is more portable than the flat form of bath, and occupies little space, the water clears itself from the dissolved salts, and the prints are more easily developed. The prints, when in the bath, are removed from the light, and when withdrawn they can be hung on the drying rods at the sides of the bath, the water draining into the troughs at each side.* The sensitized paper should be preserved from damp and the light in zinc cases. Where the locality is a damp one, it is a good plan to have the lid fitted to hold a piece of calcic chloride, to absorb the moisture.

No. 1.—*Cyanotype Sensitizing Process* (*Herschel's*).—White lines are produced on a blue ground with a solution of 140 grains of ferric ammonic citrate, 120 grains of potassic ferricyanide, and 2 oz. of distilled water, and the solution should be kept in a stoneware vessel. This process depends upon the actinic action of light reducing the ferric salts to a ferrous state under certain conditions, one of which is the presence of organic matter, such as the albumen or other size contained in the paper. The ferrous salt then combines with the potassic salt to form Prussian blue, which is insoluble. The sensitizing solution should be applied to cream laid paper, rolled and well sized by a flat damping brush, 6 in. wide, or a tuft of cotton waste, and the paper should be allowed to dry in the dark. The solution should be applied uniformly, and sufficiently just to cover the surface of the paper. After drying in the dark, the paper should be rolled and stored in special cases. Two or three minutes' exposure to the sun at noon, and thirty minutes in the afternoon, is sufficient when newly made sensitized paper is used. The exact degree of printing during exposure can be ascertained by the use of a small printing frame, in which sensitized paper should be exposed along with that in the larger frame, and under precisely similar conditions. Another method is to allow a part of the sensitizing paper to protrude from behind the tracing. The effect of the degree of exposure can be ascertained by watching the varying colors of the paper, which, with the blue negative cyanotype processes, change from an initial yellowish green to a bluish green, then to bluish gray, and finally to an olive green, when the exposure is complete. A 6,000 candle arc light is equal to half the actinic effect of ordinary sunless noonday light, and equal to one-sixth of the actinic effect of unclouded sunlight. At a distance of five feet from the electric arc light of 6,000 candles, an exposure of thirty minutes is required for paper sensitized by the Pellet process, and a little longer for the other cyanotype processes. As the argentic paper is four times more sensitive than the cyanotype paper, about ten minutes' exposure only is needed for paper sensitized by the argentic nitrate process. By arranging several printing frames in a circle of 10 ft. around the arc light, as many as eight large copies can be made at the same time. When it is required to copy during dark days, and where the electric arc light is not available, actinic light may be produced by a deflagrating mixture of eight parts of potassic chlorate, four parts of antimony sulphide, two parts of sulphur, and two parts of magnesium dust, but it is only suitable for the highly sensitive argentic nitrate and platinotype processes, and must not be pounded or otherwise mixed in a mortar. The development is effected by thoroughly washing the print in pure water, in the bath, for a few minutes. A little hydric chloride is occasionally added to the water to increase the intensity of the blue ground, which may be converted into black by first immersing it in a bath of caustic potash, and afterward in one of tannic acid. Development is considerably accelerated by the use of water at 90° to 100° Fahr. Only sufficient paper for two months' use should be obtained.

No. 2.—*Cyanotype Process* (*Marion's*).—White lines on a blue ground are also produced by a sensitizing solution composed of 9⅜ oz. of ferric ammonic citrate and 6¼ oz. of potassic ferric oxide, dissolved separately in pure water, and then made up to 1 quart. Both processes, Nos. 1 and 2, give good results. When positive prints (or blue lines on a white ground) are required, the sensitive paper should be of the thinnest possible description that will permit the solution to be applied without sinking through it. This thin paper should be then used in the manner described for taking a negative copy (or white lines on a blue ground), this negative copy being used instead of the tracing, and the ordinary sensitized paper placed behind it in the ordinary manner. The exposure must be considerably prolonged (from three to four times at least), and the development also occupies a longer time. To effect alterations or additions on negative prints, the following methods may be adopted. White lines may be obliterated by applying a quill pen or brush dipped in the sensitizing solution, and then exposing and developing as already described. Additions may be made with flake or Chinese white. But a more effectual method is to use a quill pen or brush dipped into a solution of 40 grains of potassic carbonate in 1 oz. of water. Immediately after applying the potash, the paper must be carefully dried with blotting paper, otherwise the effect of the solution will spread.

No. 3.—*Positive Cyanotype Process* (*Pellet's; blue lines on a white ground*).—According to an admirable treatise, this process is the most important of the existing sun copying or photographic tracing methods. It is widely used by engineers on the Continent; it gives very distinct prints, and depends upon the reduction of an organic ferric salt to a ferrous salt by actinism. Prussian blue is formed by the reaction of ferric compounds with potassic ferrocyanide; and white ferrous compounds form a white salt with the same reagent. If the paper sensitized by the Pellet process was introduced into the ferrocyanide developer without exposure, it would become entirely blue, owing to the uniform deposition of Prussian blue. Should any part have been sufficiently exposed to the light, the paper will remain white, owing to the complete reduction of the iron from the ferric to the ferrous state, the persalt of iron becoming reduced to the state of protosalt wherever the sensitive paper is unprotected by the opaque lines of the tracing. Hence the Pellet process produces dark blue lines on a white ground. The solution is made with three parts of sodic chloride, eight parts of ferric chloride, four parts of hydrogen tartrate, and 100 parts of water; and it is thickened by the addition of twenty-five parts of powdered gum arabic. The paper should be fastened down by pins, and the solution applied in the usual manner. The paper should be dried as quickly as possible, to keep the sensitive coating as much as possible on the surface of the paper. In full sunlight, one or two minutes' exposure is sufficient; but in dull weather, considerably longer time is required. With the electric arc light, the time of exposure varies from twenty minutes to half an hour. The progress of actinic action on the Pellet paper may be tested by inserting several test slips beneath a similar piece of tracing paper, on which some lines have been drawn, withdrawing these slips at different periods during the exposure, and inserting them in potassic ferrocyanide until the exposure is found to be sufficient. By adopting this simple actinographic method, much disappointment may be prevented. The paper sensitized by this process will keep for days after exposure before developing, so that when a considerable number of sun copies are required, it is advisable to expose all of them when the light is good, and to develop them subsequently at leisure. The print should be transferred into a saturated solution of potassic ferrocyanide, not immersed, but floated with the prepared face next the solution. By simply turning up the edges of the print, the developing solution is prevented from reaching the back of the print. The development is rapid, one minute being generally sufficient. A blue coloration of the ground is a proof of insufficient exposure; while weakness of the lines indicates over-exposure. If the exposure has been sufficient, the paper may be left for a considerable time in the developing bath, to increase the definition of the lines. On the contrary, should the exposure have been weak, the print must be submitted for a short time only to the influence of the potassic ferrocyanide, to avoid blue spots caused by unreduced particles of iron. After the completion of the development, the print should be floated face downward upon clean water. And in about two minutes, it should be immersed in an acid bath, composed of eight parts of hydric chloride, three parts of hydric sulphate, and 100 parts water. From six to eight minutes is sufficient time to allow for the acid reaction on the iron compounds, and for the removal of the redundant iron compounds by the acid. The print should next be thoroughly washed with water, and dried. Any blue discoloration may be remedied by a dilute solution of potassic hydrate, applied with a quill pen or brush, and blotted. The potash solution is composed of 1 part of potassic hydrate and 28 parts of water. A solution, termed blue solving, is provided for making alterations or additions on paper prepared by this process. When the helios produced by the Pellet process are discolored, they may be effectually bleached by a 4 per cent. solution of hydric sulphate in summer; and in winter this may be increased to 6 per cent. When the cyanotype, the Pellet, or Shawcross prints are intended for the workshop, they should be saturated with white, hard varnish. This will prevent the penetration of oily matters, grease, etc., and the adhesion of dirt. For rough work, the prints should be mounted on linen, with fresh, white paste, entirely free from acid and alum; apply to the back of the print.

No. 4.—*Positive Cyanotype Process* (*Pizzighillis; dark blue lines on a white ground*).—This process is very similar to Pellet's; the solution consists of five parts of powdered gum arabic dissolved in 25 parts of water, one part of ferric ammonic citrate with two parts of water, and one part of ferric chloride with two parts of water, mixed in the proportion of 30 parts of the first, eight of the second, and five of the last. At first the mixture is limpid, but it soon grows thicker. It should be applied to the paper immediately after mixing. The exposure is the same as for Pellet prints. The developing solution is composed of one part of potassic ferrocyanide and five parts of water. This solution should be carefully applied to the face of the print with a large camel's hair brush, when the delineations in dark blue will at once appear. As soon as the drawing is quite clear, the prints should be placed in a solution of 12 parts of hydric chloride and 10 parts of water. The ground will then become quite clear and white, and the gum will be removed. The print should be finally washed in clean rain water.

No. 5.—*Nigrographic Process* (*black lines on a white*

* From Selected Papers of *Minutes of Proceedings of the Institution of Civil Engineers.*

* Mr. Thwaite's form of developing bath can be obtained on application at 15 Ashcroft Buildings, Liverpool.

ground).—This process, although complicated, and requiring scrupulous care in manipulation, is worthy of a place, because of the peculiarity of the reagents used and the method of operation. The solution employed consists of 25 parts of gum arabic, 7 parts of potassic bichromate, 1 part of alcohol, and 100 parts of water. This solution should be applied to thoroughly sized paper, dried and kept in a dark place. The exposure is the same as in the ferro-prussiate or cyanotype processes. After exposure, it should be placed in cold water for twenty minutes, to wash out the unchanged bichromated gum. After drying, it should be treated with a mixture of 5 parts of shellac, 100 parts of alcohol, and 15 parts of finely ground lampblack. This black mixture should be carefully applied, by means of a sponge, to the face of the print, which should then be immersed in an acid solution of 100 parts of water and three parts of hydric sulphate. The superfluous black color can be removed by a soft camel's hair brush; and the delineations appear in black lines on a white ground.

No. 6.—*Platinotype Process* (*Willis'; white lines on a black ground*).—This process is based on the reducing action of a ferrous salt, when exposed to actinic light, on metallic chlorides, especially that of platinum. The sensitizing solution is composed of 60 grains of potassic platinous chloride, 60 grains of ferric oxalate, and 1 oz. of water. The proper time of exposure is about one-third of that required for the argentic nitrate process. During the exposure, the initial yellow color of the sensitized paper becomes pale grayish brown and finally of a dull orange hue. The last change indicates that the iron salt has been almost completely reduced. If the prints are not immediately developed, they should be preserved from moisture by being placed in cases in which there is a lid containing calcic chloride. The print should be developed, in non-actinic light, in a solution of 130 grains of potassic oxalate and 1 oz. of water, at a temperature of from 150° to 200° Fahr. The print should be floated in the developing solution for not less than four seconds, with the printed face next to the developing solution. As soon as the print has been properly developed in the above solution, it should be washed, either in 1 part of hydric chloride with 60 parts of water, or in 10 parts of citric acid with 100 parts of water; the hydric chloride solution being the best. The print should be washed in the dilute acid solution for about ten minutes, or until it does not communicate the slightest tinge of color to the bath; if it does, it should be reimmersed in the bath, or, better still, in a fresh-made dilute acid solution, which should remove all traces of iron salts from the paper. The prints should be finally washed in copious relays of clean water for at least fifteen minutes. This process is used by the Midland and London and North-Western Railway companies, upon the Ordnance Survey, and by the Royal Engineers, and gives most exquisite prints.

No. 7.—*Gallic Acid Process* (*Shawcross' direct positive; black lines on a white ground*).—This process is one of those now employed by the author; and by giving a direct positive black copy, has a considerable advantage over the other processes described. The reagents employed are inexpensive, and the process is comparatively simple. A gallo-tannate of iron is formed by the combination of gallic or tannic acid with a ferric salt; and this latter salt, on exposure to light, is converted into the ferrous state. The part of the paper preserved from light, not being changed by actinism into the ferrous state, is ready to combine immediately with the gallic acid on immersion in a suitable solvent such as water. The sensitizing solution consists of 150 parts of gelatine, 60 parts of ferric sulphate, 94 parts of sodic chloride, 18·8 parts of hydrogen tartrate, 150 parts of ferric chloride, and 1100 parts of water. The solution should be uniformly spread over the surface of the paper by means of a roller pad or flat brush (the roller pad being preferable), and the paper dried in the dark. It should then be dusted over with finely powdered gallic or tannic acid; and the powder should then be thoroughly rubbed on the paper until it is brought into contact with every part of the sensitive surface. It is now ready for use. As soon as the yellowish color of the paper is converted into white, the exposure is complete. The lines of the drawing will appear in the initial yellow color until the print is immersed in the developing bath of water, when the yellow lines will at once be converted into a dark color approaching to black. If exposed too long, the yellow lines of the drawing will entirely disappear. The prints should be thoroughly washed in two relays of water, the surface of the print being carefully rubbed over with a stiff brush while submerged in the water of the bath. The more thorough the washing, the better is the print; as, although the print may appear white after the first washing, subsequent exposure to sunlight will probably show disagreeable discolorations in the white surface. Lines may be altered, or stains removed, by using a 1 per cent. solution of hydric sulphate. When a more rapidly sensitizing solution is required, either glucose or dextrine may be substituted for the gelatine, which will give a violet or purple hue to the reproduced lines on the sun-copy. Blue lines can be produced by substituting potassic ferrocyanide for the gallic acid; red lines by substituting potassic sulphocyanide for the gallic acid; and green lines with catechu. The author strongly recommends the use of this process, which is the invention of Mr. Shawcross, of the Water Engineer's Office, Liverpool; for it does not require an acid solution for development; the exposure may be determined by simple examination; it gives a direct positive, and practically black copy; colored tracings may be reproduced, as it reproduces half tones; and the copy is in ink (gallo-tannate of iron), and is permanent.

No. 8.—*Argentic Nitrate Process* (*white lines on a black ground, or vice versa*).—This process, although far more expensive than the other processes described, is advantageous when small, intricate, and delicate drawings require to be reproduced. When organic matter, such as the albumen of albumenized paper, is brought into contact with a soluble salt of silver, a definite compound of argentic albuminate is formed, which on exposure to light becomes dark colored. It is inferred, from chemical considerations, that although the dark compound is not argentic oxide, yet the coloration is dependent on the formation of argentic oxide. Argentic albuminate is white, but becomes dark red brick color in the presence of actinic light. If gelatine is used as the size instead of albumen, it combines with the silver, and on exposure to light assumes a red tint. If starch is used for the size, exposure to actinic light converts argentic starch compounds into a dark violet color. The sensitizing solution consists of 60 grains of argentic nitrate and 1 oz. of distilled water, with the addition of 10 drops of a saturated solution of citric acid for each ounce of argentic nitrate. This solution should be poured into an earthenware bath for a depth of ⅛ inch, and is prepared by thoroughly mixing together 154·3 grains (10 grammes) of ammonic chloride, 0·264 pint (15 cubic centimeters) of alcohol, and 2·37 pints (135 cubic centimeters) of water, and then gradually adding eight pints (450 cubic centimeters) of albumen. Its application should be effected as follows: The paper should be held by the two opposite corners, in such a way that it will first touch the surface of the solution on a line between the two corners not held by the hands. The two corners held in the hands are then dropped, first one and then the other. Any air bubbles can be removed by gently moving the paper, while half is held out of the solution. If the edges of the paper curl away from the solution, they may be gently blown down to the surface. The paper should be gently drawn from the solution by the adjacent corners, so that it may be drained while it is lifted; and it should then be dried.

A few minutes' exposure in sunlight is sufficient; and when the color of the print becomes a deep chocolate tint with metallic reflections, it is sufficiently exposed. After removal from the printing frame, the print should be thoroughly washed in copious relays of water. The print may be toned in a solution of one grain of auric chloride, 30 grains of sodic acetate, and 10 oz. of water; and it should be allowed to remain in this solution for fifteen minutes. After again washing in rain or distilled water, the print should be immersed in a fixing solution of 4 oz. of sodic hyposulphite and 1 pint of water, for fifteen minutes, and afterward thoroughly washed in several changes of water, or with a copious supply of water from an India rubber tube.

No. 9.—*Uranium Salt Process* (*brown or gray lines on a white ground*).—This process is based upon the reduction of uranic nitrate to the uranous state in the presence of organic matter, such as the size contained in the paper, and under pressure to actinic light. The sensitizing solution consists of 617·2 grains (40 grammes) of uranic nitrate and 4·4 pints (250) distilled water.

The paper should be floated, as in the argentic process, for about eight minutes in a bath of the above solution, and after drying is ready for use. The time of exposure required for this paper is rather longer than that required for the argentic process.

If a brown copy is required, the exposed side of the paper is floated for about five minutes, or until the details are completely visible, on a developing solution consisting of 15·43 grains (1 gramme) of potassic ferricyanide, two drops of hydric nitrate, and 4·4 pints (250 cubic centimeters) of water; and the print should then be thoroughly washed in slightly acidulated water. If gray lines are required, the developing solution should be made with 30·86 grains (2 grammes) of argentic nitrate, three or four drops of acetic acid, and 0·54 pint (40 cubic centimeters) of water.

The print should be floated on this solution, when the delineation will rapidly become visible. If the lines are weak, they may be strengthened by adding a few drops of a saturated solution of gallic acid. The print, when fully developed, should be thoroughly washed in pure soft water free from carbonates or chlorides.

No. 10.—*Gelatine Process* (*Poitevin's*).—This process is based on the peculiar property possessed by the ferric salt of rendering gelatine insoluble, so long as it is not exposed to actinic rays. The sensitizing solution is composed of 10 parts of ferric chloride, 3 parts of hydrogen tartrate, and 100 parts of water. Before the paper is coated with the sensitizing solution it should be floated on a 6 per cent. solution of gelatine while this is still warm, and with which is mixed any suitable pigment of the desired color, such as lampblack.

When dry, it should be immersed in the sensitizing solution, and afterward dried; and it is then ready for use. The paper should be sensitized and dried in non-actinic light. The sensitized paper should be placed behind the tracing or drawing, reversed as regards right and left. The time of exposure varies from half a minute to several hours, according to the intensity of the light and the thickness of the paper.

The gelatine surface which is not covered by the lines of the drawing becomes soluble in hot water on exposure to the light. After the paper is removed from the printing frame, it should be immersed in water at a temperature of 80° Fahr., when the soluble gelatine will run off the paper.

No. 11.—*Ammonic Bichromate Process* (*Cros and Vergeraud's; dark brown lines on a white ground*).—The theory of this ingenious process, communicated to the Academy of Sciences, is probably as follows: The action of actinic light converts the bichromate, in the presence of organic matter, into chromium, and renders the organic matter insoluble. The ammonium is dissolved in the solvent; and the chromium, in the presence of argentic nitrate, becomes converted into argentic bichromate.

The sensitizing solution consists of 30·86 grains (2 grammes) of ammonic bichromate, 231·48 grains (15 grammes) of glucose, and 1,543·2 grains (100 grammes) of water. The time of exposure in similar to that of the Pellet process, and should be continued until the initial yellow color of the sensitized ground is converted into gray. The print should then be immersed in a solution consisting of ten parts of acetic acid, eighty-eight parts of water, and one part of argentic nitrate. The lines will come out of a red color, which, on drying, will become converted into dark red.

Printing on Fabrics.—The best description of textile fabrics for this purpose is fine linen, or the finer kinds of cotton fabrics (nainsook, for example). When silk is used, the denser kinds of sarsanet and the soft silks are the best. To albumenize or size the fabric, it should be boiled in water made alkaline by the addition of a little potash, and after drying, it should be coated with a sizing solution composed of 30·86 grains (2 grammes) of ammonic chloride, 4·4 pints (250 cubic centimeters) of water, and the white of two eggs.

The sensitizing operations by the various processes can be performed as for paper, with the exception that, with the argentic nitrate process, 70 grains of argentic nitrate should be used instead of 60. The exposure and developing operations are the same as for paper, with the exception that, with the platinotype process, the acid solution should be composed of one part of hydric chloride and forty-five parts of water.

The Platinotype Company prepares special solutions for the application of the platinotype process to fabrics. If treated with the platinotype solution, the printed fabric can, according to Mr. Willis, be washed when soiled without injury to the image. Fabrics should be sensitized in non-actinic light, or by gas or lamplight.

A good method is to lay the fabric on a glass plate, and apply the sensitizing solution by means of a sponge until the fabric is thoroughly saturated. The material should then be carefully dried, by gently waving it backward and forward before a stove until it is quite dry. The fabric should not be brought nearer than 2 feet from the drying stove, otherwise the sensitizing solution will undergo decomposition. After sensitizing, the fabrics should be preserved from damp.

No. 12.—*Zincographic Process.*—This process is used in some of the Continental drawing offices, among others, that of the Belgian department of the Ponts et Chaussees. It has this advantage over the other processes described, that when once a zincograph copy has been obtained, any number of duplicates can be reproduced by sending the copy to a lithographic copper plate printer. Asphaltum, or bitumen, is the sensitive agent, and was discovered by Niepce de St. Victor.

Its application for the production of photographic images was the forerunner of the invention, by his coadjutor Daguerre, of using the iodide of silver as the sensitive agent. Asphaltum, when exposed to light, becomes insoluble to ordinary solvents, so that when it is exposed under a tracing, the opaque lines of the drawing prevent the asphaltum from becoming insoluble. The best asphaltum for this purpose is that obtained from the shores of the Dead Sea in Syria, and is commonly known as Jews' pitch; but it is also obtained from the islands of Cuba and Trinidad.

To prepare the asphaltum for use, it should be dissolved in turpentine or benzole, quite free from water; and to this should be added 10 per cent. of oil of lemons. The quantity of asphaltum should not exceed 5 per cent. of the benzole. Only sufficient solution should be prepared to serve for immediate use; and the sensitizing solution should be prepared in non-actinic light, and allowed to settle. A zinc plate should be used of the same size as the tracing to be reproduced, and should be evenly covered with a film of the sensitizing solution. In order to obtain a perfectly even film, the plates should be placed on a horizontal table or board, which can be quickly turned or spun round by hand.

As soon as the sensitizing film is even and uniform, it should be allowed to dry; and if turpentine has been used to dissolve the asphaltum, this will take an hour, or perhaps more. If benzole is used, it will dry far more quickly; and the drying operation can be controlled by the use of oil of lemons, etc The tracing, reversed as regards left to right, should be placed in the printing frame, and the zinc plate should be placed with its sensitized surface next to the tracing, and clamped down or otherwise pressed to it. To prevent the adhesion of the sensitized surface to that of the tracing, the former should be rubbed over with powdered French chalk.

The time of exposure varies with the degree of intensity of the light and the thickness of the asphaltum film; but in sunlight thirty minutes at least are required, even with the thinnest films. Longer periods, varying from two hours to twenty-four hours, are needed for thicker films. By using an actinograph, similar to the method recommended for the other processes, the progress can be watched. A small piece of zinc, covered with the same solution of as near as possible the same thickness, should be applied under identical conditions. If by rubbing it with a piece of cotton waste dipped in turpentine or benzole the cotton becomes discolored, the exposure is not complete. The edge of the zinc plate can also be tested in the same way.

The plate should be developed by the aid of a ruby lantern. The development is effected by gently rubbing over the sensitized surface with a tuft of cotton dipped in olive oil. After the expiration of a few minutes, it should be gently rubbed over with turpentine. The image will gradually appear, and the alternate process of rubbing with oil and turpentine should be continued until the soluble parts are cleared. The plate should then be washed with soap and water, and finally washed in a copious supply of clean water, and then dried, after absorbing the water with blotting paper.

Another method consists in filling a bath with turpentine and immersing the plate therein, gently rocking the plate until the soluble parts of the asphaltum are washed off; but care must be taken not to allow the turpentine to dissolve the parts which should be insoluble. The plate should be finally rinsed with clean turpentine, and then washed with water until the soluble parts are cleared off, and lastly dried.

This immersion operation requires more care than the rubbing method, but it is more rapid. A solution of nitric acid, made by adding to it twice its volume of water, should then be applied, either with a quill or a tuft of cotton waste, to the exposed parts of the zinc plate, until it is sufficiently etched for printing by a copper plate printer. In the preparation of asphaltum it is found that a greater degree of sensitiveness and sharpness of definition is effected by adopting the following process. The asphaltum is dissolved in rectified oil of turpentine until the solution attains a sirupy consistency.

After resting a few days, ether is added to the solution to the extent of three to four volumes, and two days subsequently the resulting precipitate is removed and washed with ether and dried; it is then redissolved in pure benzole, to which 1·5 per cent. of Venice turpentine is added to produce a more flexible coating, and it is then ready for use. The exposure and the development are the same as for the asphaltum prepared in the ordinary manner.

THE value of the cotton plant, great as it is acknowledged to be, seems to have the possibility of being increased, since it has lately been discovered that the bark of the root contains what promises to be an available coloring matter.

THE WELSBACH INCANDESCENT GAS BURNER.

THE production of light for illuminating purposes by the incandescence of a refractory material has been the cherished object of many inventors, some of whom have so far developed their ideas as to have brought them more or less successfully from the laboratory into the market. The Clamond, Popp, Lewis, and more recently the Lowe and the Auer von Welsbach systems, are those of which we have heard the most, and which have found a more or less extended practical application. This last named has been for a considerable time tested on a large scale in Vienna, and is now being somewhat tardily brought to the notice of the public in this country. Before Auer von Welsbach, a Viennese scientist, discovered the way to utilize one of the most refractory of known materials, zirconia, highly resistant earths and metals had been employed. Thus the Clamond system comprises the use of magnesia either in filaments, slabs, or pencils, against which the intense heat produced by a modified Bunsen burner is projected. Popp, Lewis, and Lowe, on the other hand, employ a cage of platinum, but in each of the two typical systems, gas and air have to be supplied to the burner at exceptional pressures, involving special arrangements which complicate the process, and limit the range of their applications. With water gas such special arrangements are unnecessary, and we believe that at many factories in Germany, where water gas is made use of, the Clamond system is found to give satisfactory results. The pencils of magnesia, however, require very frequent renewal, and although the cost thus incurred is insignificant, the comparatively short duration of the incandescent material presents a grave difficulty. In those systems, also, where cages of platinum wire are employed, the same objection applies with greater force; for not only does the platinum soften and absorb carbon under the continued action of intense heat, but the color of the light is not good, and the cost of renewal is relatively heavy.

The system of Prof. Auer is one of extreme beauty and ingenuity. He extracts by a complicated chemical process the metal zirconia from one or other of the several zircon ores found in nature, and combines it in solution with solutions of lanthanum and of one or more other rare and refractory metals, to obtain the basis on which his incandescent light depends. With the fluid thus produced he impregnates a hood of finely woven fabric, which, when dry, is suspended over a Bunsen burner and ignited. The combustible fabric is burnt away, the water of the solution evaporated, and there remains a delicate, an extremely delicate, zirconian counterpart of the original fabric, shrunk, of course, but perfect in every mesh. Prior to impregnation, the top of the hood is secured by a fine platinum wire, which subsequently serves as a means of support, it being attached to a stem placed in the fittings of the lamp. The burner employed is of the Bunsen type, modified by an old and well-known device, so that it can be turned down without "lighting back," and the heat thus obtained, without any augmentation of pressure, is sufficient to bring the zirconia skeleton to a state of brilliant white incandescence, the luminous energy of the gas consumed in this way being considerably higher than when burnt in the most economical gas burner. As much as seven or eight candles per foot of gas burnt per hour can be obtained, though probably this is considerably higher than the average that would be given. There being no flame, the light is absolutely steady.

An installation of Welsbach burners has been erected at the Marlborough Gallery of Paintings, 53 Pall Mall, S. W., and awakens the admiration of all who see it, both for the absolute steadiness of the light and for the beautiful quality of the illumination, which has a tone intermediate between that of an electric incandescence and an arc lamp. All the shades of green and blue in the paintings hung on the walls of the gallery come out with perfect accuracy, and it only needs the substitution of another source of light to render evident the great difference between gas burned under the Welsbach system and any other in vogue in this country. Fifty-six burners are arranged in two rows along the center of the room, and provide an illumination which is perfectly steady and noiseless, free from all dirt and smoke, and far less heating than usual, since little more than only one-third the ordinary quantity of gas per unit of light is consumed.

The burners at the Marlborough Gallery are, we believe, of Austrian manufacture, but their production in this country is being attempted. Those we are describing are formed of a Bunsen burner having a gas jet on the principle of the watering rose, that is, with a number of small holes through which the gas is emitted in fine streams which mingle with air entering the mixing tube at the sides, in the usual manner. This arrangement gives a short flame of great heat, and one which is quite free from all hissing sound. The gas burns at the outlet of the mixing tube, within a hood or mantle formed of zirconia, as already described. This hood is made originally from hoisery fabric in the form of a tube, and is supported by a ring of platinum wire at its upper end. The tube is first doubled on itself, and then the wire is sewn into it, thus securing the hem, and forming a means of attachment. By the aid of two extensions, the wire ring thus formed is secured to a support, and the hood is held over the flame. According to another method of manufacture devised by Mr. A. Paget, of Loughborough, the hoods are each made separately on a hosiery frame, and are provided with a channel, such as ladies call a string case, at the upper edge. The platinum wire is threaded through this channel, and is provided with a cross-loop, like a bucket handle, by which the hood can be suspended from a hook. This arrangement gives a neat appearance to the hood, and causes the shrinkage to take place in a more symmetrical manner, avoiding plaits which may ultimately become sources of weakness owing to unequal temperature.

As the hood, after its incineration, is extremely fragile, it is necessary that it shall be protected as far as possible from the dangers of transport and handling. For this purpose the attachment, from which it is suspended, is fixed to a gallery which forms the base of the chimney, and the three constitute a compact piece which can be moved safely. The hood cannot be unintentionally removed from the inside of the chimney, and the presence of the glass insures that reasonable care will be exercised in handling, even by ignorant servants. In connection with the gallery, which slides over the mixing tube of the burner, there is a grid which fits on the tube and prevents the flame striking back when the gas supply is reduced.

Experiments made recently showed that with a consumption of 2·4 cubic feet of gas, at a pressure of 0·9 inch to 1 inch of water, an illumination of 18 standard candles was obtained, or an efficiency of 7·5 candles per cubic foot of gas. It is needless to say that this is a most successful result, and that if considerations of economy of consumption were the sole elements in the relation of gas burners, the Welsbach light must supersede all others. The question of the durability of the hood has, however, to be taken into account. Considering the very delicate nature of this part, which must not be subjected to rough usage of any kind, it is probable that in ordinary use comparatively few will perish of old age, but will be destroyed by accident. Laboratory experiments, however, show a duration of 1,000 hours, with but little reduction in the light-giving qualities, and we believe that 2,000 hours have been reached without remarkable deterioration. It is evident that if limits like these could be approached as an average, the cost of renewals would be insignificant, and the trouble involved inappreciable. But it is not likely that in common use, where the delicate film is exposed to careless and ignorant handling, and to all the thousand and one shocks of every day life and work, great longevity will be reached, and the item of cost and trouble may then enter as important factors in the equation of real usefulness. On the other hand, there is a large margin in economized gas—50 per cent. is not too high an estimate—and this saving will balance damaged hoods and tired patience to a large extent, while an absolutely pure and steady light, a reduction in proportion to that of the gas consumed in vitiated atmospheres, are no small advantages.

We believe that the Auer von Welsbach system has an extended field of usefulness before it, and that it will grow rapidly in favor in places where sufficient gas is burned to render it worth while for some with a capacity beyond that of domestic servants to take charge of the fittings, and until it is challenged by some robuster and equally efficient rival, which will defy the destructive finger of the British housemaid. The Welsbach system with an actually, not relatively, strong hood would be practically perfect. It is for those interested in the question to arrive at this desideratum, and unless they can do so they can scarcely hope to hold a monopoly in gaslighting by incandescence, which promises to be for a time, at least, "the light of the future."—*Engineering.*

DETERIORATION OF BLEACHING POWDER.

THE rate at which bleaching powder (chloride of lime) loses its chlorine is becoming more important now that the price of the substance is advancing, and the rise promises to be permanent. By the old or Leblanc process of making sodium carbonate, hydrochloric acid was a waste product, and to save himself the manufacturer had to utilize its chlorine by passing the gas over lime, and forming the well known bleaching powder. But by the new or Solway process of making sodium carbonate, no hydrochloric acid is produced. To generate the acid for the purpose of making bleaching powder would necessitate a great increase in the cost of the latter, and this is just the situation which confronts the bleaching industry today. Self-preservation dictates an inquiry into every cause of loss, and what takes place when the powder is stored, whether for sale or use, especially demands investigation.

Mr. John Pattinson, of Newcastle, England, began with this object a series of experiments two years ago, the results of which have recently been published. He took three casks of the usual size, each containing about six cwt. of bleaching powder, and also samples of the same kind kept in bottles holding four oz., testing the contents of all monthly.

Two of the casks, marked respectively A and B, were filled with bleaching powder made of Irish limestone from Larne, by different manufacturers. The third cask, marked C, contained bleaching powder made of "French Cliff" limestone. Twelve bottles of each kind of powder were filled at the same time, the casks sealed, and both casks and bottles were stored in a cellar. A maximum and minimum thermometer was placed near them, and a careful record of the temperature made each working day during the year. The record shows the temperature to have been uniform and comparatively low during the entire year, the highest being 62° F., and the lowest 38° F.

In taking the samples from the casks, each cask was bored in a different part, at the end of each month, a sample withdrawn and tested. A complete analysis of each of the cask samples was made at the beginning and also at the end of the experiments. These analyses are given in the table below. The bottle samples were also examined at the beginning and at the end of the period for chlorine existing as available chlorine (hypochlorite), chlorate and chloride. The methods of analysis employed were the following: The available chlorine was determined by Penot's method; that is, with a standard solution of arsenious acid. To determine the chlorine existing as chloride, the portion in which available chlorine had been determined was acidulated with nitric acid, the excess neutralized with carbonate of lime and then titrated with a solution of nitrate of silver. The difference between the amount of chlorine thus indicated and the amount indicated by Penot's test gives the chlorine existing as chloride of calcium. To determine chlorine existing as chlorate, a portion of the bleaching powder was boiled with a solution of sulphurous acid, to reduce both chlorates and hypochlorite to chlorides. After excess of sulphurous acid was expelled by boiling, and by the addition of a few drops of nitric acid, the solution was neutralized by carbonate of lime, and the total chlorine then contained, by titration with standard nitrate of silver solution. The difference between the total chlorine and that existing as hypochlorite and chlorine gave the chlorine existing as chlorate. The other constituents were determined by the usual methods of analysis.

In examining the table, it will be seen that on the whole there has been a gradual and regular loss of available chlorine during the time over which the tests were made. The total loss of available chlorine in each sample was as follows:

	Casks.	Bottles.
A.........	3·20 per cent.	2·30 per cent.
B.........	3·20 "	1·80 "
C.........	3·10 "	1·80 "

It must be mentioned, however, that in the case of the casks, the above percentage of loss of chlorine is too small, as is apparent on referring to the table below, where it will be seen that the cask samples have absorbed carbonic acid and water from the atmosphere during the year, and thereby increased in weight. The amount of this absorption is no doubt greater in these experimental casks than it would be in casks under ordinary circumstances, for the gradually increasing number of holes bored in these casks and into the middle of the bleaching powder necessarily allowed greater access of air to the bleaching powder than would be the case with casks that are not so treated. The additional amounts of carbonic acid and water absorbed by the cask samples were as follows:

Cask A............................	2·32 per cent.
Cask B............................	2 05 "
Cask C............................	2·95 "

The average loss in the cask samples was 2·32 per cent., and in the bottle samples 1 97 per cent.

The small quantity of chlorine found as chlorate at the beginning of the experiments ceased to exist in this combination at the end, and from tests made it was found that all the chlorate had disappeared in May, or about four months after the casks were filled.

The amounts of chlorine existing as chloride had slightly increased.

It is not often, however, that bleaching powder can be stored where so low a temperature as 60° F. can be maintained for any length of time, at any rate in the summer months. The experiments made in 1874 indicated that a much greater loss of available chlorine took place during the summer months than during the colder winter months.

COMPOSITION OF BLEACHING POWDER.

	January 29, 1885.			January 5, 1886.		
	A	B	C	A	B	C
Available chlorine........	37·00	38·30	36·00	33·80	35·10	32·90
Chlorine as chloride.....	0·35	0·59	0·32	2·44	2·42	1·97
Chlorine as chlorate......	0·25	0·08	0·26	0·00	0·00	0·00
Lime.	44·49	43·31	44·66	43·57	42·64	43·65
Magnesia..................	0·40	0·31	0·43	0·31	0·36	0·38
Silicious matter........ ..	0·40	0·30	0·50	0·50	0·40	0·50
Carbonic acid...........	0·18	0·30	0·48	0·80	0·48	0·34
Alumina, peroxide iron, oxide manganese.......	0·48	0·45	0·35	0·40	0·40	0·37
Water and loss	16·45	16·33	17·00	18·15	17·20	18·89
	100·00	100·00	100 00	100·00	100·00	100·00
Total chlorine........	37·60	38·97	36·58	36·24	37·52	34 87

The small proportion of silicious matter, alumina, magnesia, iron and manganese in the bleaching powders, each tested, show the limestone from which they were made to have been of remarkable purity. Not only as bearing on the question involved, but as a standard for future comparison is the above table valuable, and we hope our practical readers will preserve it for future use.

THE EXPLOSIVE "KINETITE."

AT a recent meeting of the Society of Chemical Industry, held at Burlington House, London, under the presidency of Mr. David Howard, F.C.S., Mr. Watson Smith, of Owens College, Manchester, read a paper upon the substance "kinetite." The author stated that "kinetite" can be easily and safely mixed and transported, and that when detonated in open spaces, the explosion is confined to the part struck, and does not spread into the surrounding substance; consequently, under such conditions, it can hardly be called an explosive. It belongs to a class of bodies investigated and described many years ago by Dr. Sprengel in the "Memoirs of the Chemical Society." The particular recent variety known as "kinetite" is the subject of a German patent, and is manufactured in that country by Messrs. Petry & Fallenstein. It is a plastic substance, the constituents of which may vary a little, and, as originally described, consists of nitro-benzene, 16 to 21 per cent., in which from ¾ to 1 per cent. of gun-cotton is dissolved, so as to form a jelly; from 75 to 82¼ per cent. of alkaline chlorates or nitrates are then mixed in, together with from 1 to 3 parts of antimony pentasulphide. At one time "kinetite" was dearer than blasting gelatine or dynamite, but of late the price of nitro-benzene has been greatly reduced. It has five or six times more explosive power than gunpowder, and is of pasty consistency, so that it can be rolled into form in the hand, and that without danger, as it produces no headaches or other unpleasant consequences. As an example of the treatment it will bear without exploding, a "kinetite" cartridge was placed in a tube, and the plunger brought to bear upon it, while surmounted by a plate with a weight of 85 kilo. on the top. The plate was made to produce friction by rotation, and the weight at the same time was subjected to blows from a heavy hammer; and yet no explosion resulted, the kinetite was simply greatly compressed. "Kinetite" is patented in this country by Wilkins, who, however, has obtained no license for its manufacture, because he has been unable to satisfy the requirements of the Secretary of State. The Home Office at first objected to the presence of antimony pentasulphide, and when this was left out, aided by a modification of the rest of the formula, the Home Office once more refused a license, on the ground that a glancing blow from a broomstick, on a soft deal floor, would cause "kinetite" to explode. He (Mr. Watson Smith) was willing to sit in a room with such a floor covered with "kinetite," provided he had a few buckets of water with him, and they might make explosions with glancing blows, as the explosions would not spread to the surrounding substance. Dr. Lunge, of Zurich, had made numerous experiments with "kinetite" free from antimony pentasulphide, and he reported to the Swiss Government that it belonged to the least dangerous of explosives known to him in relation to carriage, manipulation, and storage. The materials might be transported separately, and mixed when required for use; but there was an advantage in mixing the gun-cotton with the nitro-benzene first, because it made it non-explosive; the solution, in fact, could be boiled with safety. The author had tried

many experiments as to the stability of "kinetite," which he thought to be safe enough if made from pure materials free from acidity. He made his "kinetite" of pure nitro-benzene, in which he dissolved 5 per cent. of gun-cotton, so as to form a jelly; with 22 parts of the jelly he mixed 72 parts of chlorate of potash and 9 parts of nitrate of potash. He then described various experiments made by himself and others with "kinetite," and stated that when it was exploded in thick leaden tubes, it seemed to act very evenly in all directions, bulging the tubes into bulbous forms—much as glass may be made to take a bulbous form in the hands of a glass blower. It was impervious to water, so needed no case when exploded under water. Finally, he performed various experiments with it before the Society, in one of which he placed it upon a block of wood, and for three or four minutes gave it glancing blows with a mallet without its exploding.

PYROMETERS FOR PORCELAIN KILNS.

IT is well known that the quality of porcelain and the different products of the ceramic arts depend in a great measure upon the temperature to which they have been exposed and to the kind of baking employed; it is, therefore, highly important that some accurate method of controlling the heat, and determining exactly the differences of temperature in the kiln, should be devised. As the ovens have often a capacity of over 3,000 cub. ft., there is considerable difficulty in obtaining a uniform temperature throughout. The two essential points for the manufacturer to aim at, in order to insure regularity in the quality of his products, are, first, to have his plant erected in the best possible way to secure uniformity of temperature; and, secondly, to be able to properly control and regulate the fire. The best forms of furnaces should have the source of heat and the orifices for the exit of the products of combustion arranged symmetrically with regard to the space required to be heated. The furnaces should be as numerous as possible, so that the flame may play round the whole periphery of the space to be heated, and thus secure a great number of places at the same temperature. The products of combustion should be as intimately mixed as possible while in the oven, and should be there sufficiently long to utilize the greatest amount of heat. The furnace which fulfills these conditions most nearly is that with reversed flame. In this furnace, the products of combustion, in virtue of their smaller density, rise to the upper part of the kiln, and are there reflected back to the base, where the exit tube is situated. This double movement insures complete mixture of the gases, and prolongs the time of their duration in the furnace. The combustion commences at the entrance, and is completed at the exit of the furnace. M. Ch. Lauth and G. Vogt have, in a memoir recently presented to the Chemical Society of Paris, given an account of their experiments, which have extended over a series of years, made with a view to ascertain in a practical manner the changes which take place in the temperature of a furnace of this description. During the first steps in heating, the eye can readily distinguish the moment when the furnace passes from a black to a dull heat color; but above this temperature it is no trustworthy guide. The different methods proposed to supplement the eye are very numerous, and have all been examined by MM. Lauth and Vogt. The purely scientific method of Becquerel, based on the thermo-electric pile, they consider more fitted for the laboratory than for use on a commercial scale. Methods which have an industrial application are based on the dilatation of solids and gases, on the contraction of clay, on the variations in the electric resistance of metals with change of temperature, on dissociation, and on changes in the fusion point of certain glasses and boro-silicates. Pyrometers based on the dilatation of solids are rapidly falling into disuse, as it is now well known that continual heating changes the rate at which such bodies expand, owing to alterations of their physical state. With gases, the difficulty of finding a suitable material in which to imprison the gas has not been satisfactorily overcome, except in the gas thermometer devised by Berthelot, which, with slight modifications, can be employed with advantage for temperatures not far short of 1,000° C. The pyrometer due to Wedgwood, in which the contraction of clay by heat is the means used for registering the temperature, is open to the objection of the difficulty of procuring clay of the same composition, and to variations caused by prolonged heating in its contractility. At the Sevres porcelain manufactory, the Siemens pyrometer has been the object of numerous experiments, and it has been found that the conductivity of platinum, submitted to great changes of temperature, changes with the molecular condition of the metal, and that the results obtained by it are not reliable after a certain time. Sauvy's pyrometer, based on the dissociation of carbonate of lime, is to be condemned, since all the carbonic acid is not reabsorbed by the lime on cooling, and no suitable material is known for containing it. The water pyrometer, due to Boulier, and described some two years ago by Lauth, is, however, capable of giving good results. This pyrometer consists of a thin copper cylinder, several centimeters in length, and having one end closed, while the other terminates in two tubes, one of which is connected with a reservoir of water, and the other is joined to a thermometer. In order to make an observation, the thin copper tube is introduced in the furnace the temperature of which is to be ascertained, and a current of water is caused to circulate from the reservoir. The water in the cylinder is heated by contact with the hot air or flame, and the rise of temperature marked by the thermometer at the exit. In order to insure the regular circulation of the water, an electric balance is introduced into the copper vessel, which, at the least interruption, stops the flow of the water. Up to the present time, the readings given by this pyrometer have been empirical. M. Auscher, the principal of the Sevres manufactory, has, however, succeeded in establishing a relation between the readings of the thermometer and the actual temperatures of the furnace, by observing the melting points of various metals. By means of this instrument, the melting point of an alloy of platinum containing 40 per cent. of gold was found to be 1460° C., while the alloy with 30 per cent gold melts at 1535°. Of these two alloys, the first alone was melted in the furnace used for "hard porcelain;" the temperature, therefore, at which this variety of porcelain fuses must be about 1500°. By a similar method, the point of fusion of "new porcelain" is fixed at about 1350°. Another method for ascertaining high temperatures, used with success at Sevres, consists in employing different alloys of known composition, similar to those used in controlling the readings of the water pyrometer just mentioned. For temperatures between 960° and 1075°, a gold-silver alloy is used, and above this temperature an alloy of gold and platinum. The following table gives the melting points, in centigrades, of some of the more important of these alloys:

1. *Silver-Gold.*

Silver.	Gold.	Melting Point.	Silver.	Gold.	Melting Point.
100	0	954°	40	60	1020°
80	20	975°	20	80	1047°
60	40	995°	0	100	1075°

2. *Gold-Platinum.*

Gold.	Platinum.	Melting Point.	Gold.	Platinum.	Melting Point.
95	5	1100°	45	55	1420°
90	10	1130°	40	60	1460°
85	15	1160°	35	65	1495°
80	20	1190°	30	70	1535°
75	25	1220°	25	75	1570°
70	30	1255°	20	80	1610°
65	35	1285°	15	85	1650°
60	40	1320°	10	90	1690°
55	45	1350°	5	95	1730°
50	50	1385°	0	100	1775°

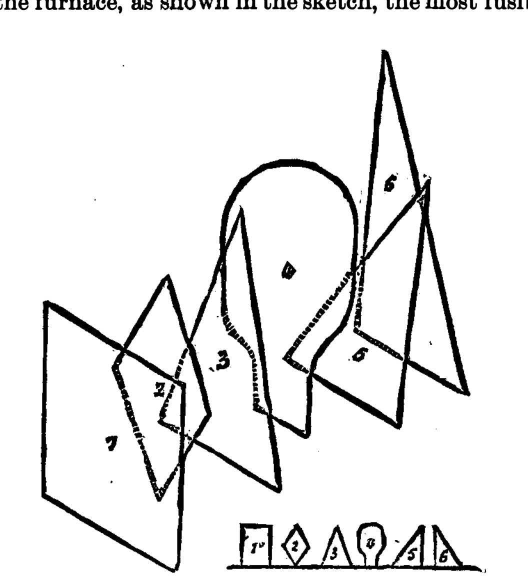
These alloys can be used for ascertaining the temperature, then, from 954° to 1775°; but, in addition to their expense, they are difficult of preparation. MM. Lauth and Vogt have, for technical purposes, replaced these alloys by mixtures of certain substances whose temperature of melting has been ascertained. They are called by the authors "montres fusibles," and are made of four different shapes, having different temperatures of fusion. They are:

1.—*Rectangle.*		2.—*Lozenge.*	
Pegmatite	51	Mixture 1	15
Sand	14	Mixture 2	85
Chalk	20		
Fused borax	15		
	100		100

Mixture 2 being composed of 70 parts pegmatite with 30 parts chalk.

3.—*Isosceles Triangle.*		4.—*Circle.*	
Mixture 2	80	Mixture 2	60
Clay (Al_2O_3, $2SaO_2$, $2OH_2$)	20	Clay (kaolin)	40
	100		100

The temperatures at which these fuse are 625°, 1150°, 1200°, and 1320° respectively. These moulds are placed in the furnace, as shown in the sketch, the most fusible



in front, the less fusible behind, so that as the temperature increases they fuse one by one. From the distinct geometrical forms which they each possess, it is impossible to confound them, so the temperature can be ascertained at any particular moment by inspection. M. Seger has made a series of mixtures of feldspar, marble, quartz, and kaolin of different compositions, and determined their melting points, for a list of which we must refer our readers to the original paper ("Bulletin de la Soc. Chimique," xlvi., p. 799). He has worked at this subject independently of MM. Lauth and Vogt, but a perfect concordance exists between the two sets of results. This method of estimating temperatures of furnaces is obviously applicable to many other industries besides those connected with the manufacture of porcelain.—*Industries.*

FAST BLACK FOR YARN DYEING.

A MIXTURE of 58·3 parts by weight of hydrochloride of paraphenylendiamine and of 41·7 parts of hydrochloride of aniline yields, on oxidation, a very fast brownish black. If twice the quantity, or more, of the hydrochloride of aniline is used, the black produced is of a bluish shade, and not so fast. Instead of hydrochloride of aniline, an equivalent quantity of the toluidine compound, or of salts of thioparaphenylendiamine, can be used. The equivalent proportions for the latter would, for instance, be 35 parts by weight of hydrochloride of paraphenylendiamine and 65 parts of hydrochloride of thioparaphenylendiamine. In order to dye 100 lb. of yarn, 4 lb. to 6 lb. of either of these mixtures are dissolved in boiling water, and the solution is poured into the dye bath, which contains 3 lb. of chlorate of potash and 600 grains chloride of vanadium, with the necessary quantity of water, at 140° F. The monamines and diamines are oxidized by the chlorate of potash and vanadium compound. A soluble color is thus produced in the dye bath, which is attracted by the fibers, so that the dye bath becomes ultimately colorless. The yarn is then washed and dried as usual.

ZINC ROLLERS FOR CALICO PRINTING.

THE high price of copper has induced inventors to endeavor to employ some other and cheaper material in its stead. An alloy of zinc, tin, and antimony has been tried, but was found to be too brittle. Hardened caoutchouc was found very suitable, but in use it would be necessary to apply a method of engraving different to that practiced at present. Cast iron rollers plated with copper have also been used; but the copper does not adhere firmly enough to the iron. Depierre, who has been studying this problem, finds that zinc, mixed with a little tin, gives the best results. The metals must be pure, and it is particularly essential that they should not contain any arsenic. The rollers are cast with a strong feeding head, and the casting is cooled quickly and under considerable pressure. The roller is then turned to the proper size, and engraved. It is then placed in a bath containing 16 oz. cyanide of potassium, 13 oz. pure verdigris, 7 oz. ammonia, and 7 gals. distilled water. In order to prepare this mixture, the verdigris and ammonia are dissolved in 1½ gals. of water, the cyanide of potassium in 5½ gals. of water, and the two solutions then mixed together. The mixture should be yellowish white, otherwise a little cyanide of potassium must be added. Another mixture which has given good results is one consisting of 12 oz. sulphate of copper, 50 oz. tartrate of soda and potash, 26 oz. caustic soda solution 50 per cent., and 28 gals. of water. Previous to placing the polished roller in either bath, it is advisable to give it a very thin coating of olive oil, so that the copper be slowly precipitated. The current is produced from ten Bunsen elements; after four hours the roller is taken out, rubbed with the finest pumice stone powder, washed with water, and then again immersed for fifteen to eighteen hours. The thickness of the layer of copper is then from $\frac{1}{10}$ to $\frac{1}{200}$ of an inch, and the roller is ready to go into the printing machine. Its weight is about four-fifths of that of a copper roller, and its price about one-half. These are the advantages which M. Depierre claims for zinc rollers; but it is very doubtful how far these advantages could be realized in practice. Although the first cost of copper rollers is not inconsiderable, yet they last a long time, and, what is most important, apart from fluctuations in the price of copper, they always keep their value. It is quite different with zinc, which can only be remelted at a loss. It would, moreover, be more expensive to recopper a zinc roller than to simply turn down a copper roller. Neither does there seem to be any particular advantage in the fact of having the rollers of less weight.

NORTH AMERICAN CARRIAGE WOODS.

AT a recent meeting of the Institute of British Carriage Manufacturers, Prof. Macoun gave the following list of Canadian elastic woods suitable for carriage building:

1. Shell-bark hickory (Carya alba).
2. Bitter nut hickory (Carya amara).
3. White heart hickory (Carya tomentosa).
4. Pig nut hickory (Carya porcina).
5. White ash (Fraxinus americana).
6. Black ash (Fraxinus sambucifolia).
7. Rim or red ash (Fraxinus pubescens).
8. Chestnut (Castanea vulgaris).
9. Cherry or black birch (Betula lenta).

I. ELASTICITY.—Ash and hickory, he observed, are noted everywhere for this property, but in commerce only two species are taken into account—white ash (Fraxinus americana) and shellbark hickory (Carya alba). It is well known, however, that all the Canadian species of ash possess this property in an eminent degree, and both black and red ash have been used from time immemorial by the American Indians in the manufacture of baskets, on account of it. Red ash, or rim ash, obtained the latter name from the early settlers in Canada, because, when hammered, each year's growth separated from its fellow, and enabled the Indians to get the thin ribbon-like pieces which they use in their basket work. Much has been spoken, and even written, on the great value of "second growth" ash and hickory, yet a clear conception of what is meant seldom enters the mind. In England I have heard of the superiority of English ash as a species, but this I deny, and assert as a fact that it is due to the conditions under which it is grown. English ash is grown on lawns and in the hedgerow; ours, which reaches England in squared logs, in the close forests, where it is protected from both storm and sunshine. Second growth ash, on the other hand, is young timber grown in the corners of fences in the old settlements, or young forest growth, which has sprung into existence since the old was cut or burnt away, and has been produced under the same conditions. The same remarks are applicable to hickory, and the wood grown in the old forest bears no comparison with the second growth.

I consider elasticity a property of young wood, and the greater the exposure, the more it is produced. Should this be a fact—and I have no doubt of it—there is no reason why Canada could not produce all the ash and hickory for every variety of agricultural implement and vehicle required in England. We have millions of acres of waste lands growing up with young wood, which to-day are of no value, but which in twenty years, if merely let alone, would fully supply the English markets as well as our own.

LIST OF WOODS NOTED FOR TOUGHNESS:

1. Basswood (Tilia americana).
2. Common or white elm (Ulmus americana).
3. Rock elm (Ulmus racemosa).
4. Slippery elm (Ulmus fulva).
5. Beech (Fagus ferruginea).
6. Hornbeam (Carpinus americana).
7. Ironwood (Ostrya virginica).
8. Walnut (Juglans nigra).
9. Butternut (Juglans cinerea).
10. White oak (Quercus alba).
11. Blue oak (Quercus bicolor).
12. Pin oak (Quercus palustris).
13. Gray oak (Quercus macrocarpa).
14. Sycamore (Platanus occidentalis).
15. Red maple (Acer rubrum).
16. Whitewood (Liriodendron tulipifera).
17. Whitewood, cottonwood (Populus monilifera).

II. TOUGHNESS.—Toughness and elasticity, although often combined in the same wood, as in the various species of elm, are not necessarily produced under the

same conditions. Elasticity, as I mentioned above, is a youthful state, while toughness is produced from the interlacing of the fibers, and is found at all ages. Our three elms, common or swamp elm (Ulmus americana), rock elm (U. racemosa), and slippery elm (U. fulva), are in their young state so tough that in many cases it is impossible to split them. I have seen thousands of young elms, ranging from six inches to eighteen inches, cut down close to our railways and burnt upon the ground because they were so tough that they were almost useless for fire wood, and not worth the labor of converting into fire wood. Did English purchasers and Canadian producers understand their business better, these small trees would be cut up in Canada of the required size, or merely cut into plank and shipped to England when partly dried. Or, better still, English capital, managed by competent men in the interest of the manufacturers, or dealers in England, could produce just what was wanted, and forward direct, so that the heavy charges now paid to middlemen could be dispensed with. I see no reason why Englishmen cannot look upon Canada as an integral part of the empire, and place their money there with the same freedom they do in this little island.

Another tough and invaluable wood to the carriage builder is basswood (Tilia americana). Besides its lightness and easiness to work, it possesses the valuable property of retaining any shape required by the builder, and for the bodies and panels of carriages is unsurpassed. In both Canada and the United States it is considered a valuable wood for every purpose requiring lightness and strength. Our manufacturers use it for sounding-boards for pianos, as it will not warp, for chair bottoms, sleighs, fanning mills, and other purposes of a like nature. Bowls and wooden ware generally are made from it, besides many toys and various little articles. To the cabinet maker it is also valuable, as it can be stained any color, and often passes for much more costly woods. Whitewood is also a valuable wood, but it is becoming scarce in Canada, as it is confined to the western part of Ontario, chiefly along Lake Erie. It has been asserted with much truth that Canadian oak is far inferior to English, but the fault lies more in the conditions of growth than in any specific distinction. English elm, ash, and oak are grown in the open ground, and hence are as tough as they possibly can be, while only the full grown forest tree is shipped from Canada. No trees of these genera are cut for export in our forests, except those that will square a certain size, and therefore the timber exported is our most brittle and weak. We have now in Canada, around the old settlements, in fence corners, and in the forest, cut many years ago, an enormous quantity of young wood, ranging from twenty to sixty years of age, which is considered of no value, as there is no demand for it. This is the class of wood you want and cannot get, because your own country does not produce enough of it. You reject our forest grown wood and say it is of second class quality, and tell us our woods are far inferior to yours. I retort by telling you that you can get the wood you desire by changing your mode of purchase. Let any competent man go out to Canada and have a lot of young oak, ash, elm, and hickory sawed up into plank of the size you want. Let it be partly seasoned, and then shipped direct to the manufacturer. Then you will get good, cheap raw material, and with your machinery and skilled workmen there is no reason why you cannot build carriages of better quality and more cheaply than you do at present.

So that you may understand the ignorance that prevails in Canada regarding our own woods, I will relate one or two instances of this character. Last autumn I was collecting samples of wood for the Colonial and Indian Exhibition, and went for that purpose to the Niagara peninsula. At Queenstown Heights I purchased a lot of second growth hickory for hammer handles for the use of the Geological Survey, and at Niagara Town, Clifton, and St. Catharines I found hickory almost the principal fire wood, and piled up in every person's yard. At the manufactories in St. Catharines I learn they use imported hickory, and put their own in the fire, while west of them, on the line of the Canada Southern Railway, numerous sawmills were at work cutting hickory into spokes and hubs for the American market. I visited the mills myself, and saw them at work. One of the chief causes of our gross ignorance is the want of a forestry department and staff of competent men to enlighten the people. The probabilities are that the Dominion Government may take the matter up at an early day, and at least the worst features of the constant burnings be somewhat curtailed.

III. Resistance to Wet.—Many trees, under certain conditions, rot easily, while under other conditions they are almost imperishable. Basswood was early considered a poor wood for fencing, as it rotted so easily. Observations showed that with the bark on it soon rotted, but without the bark it remained sound. The same thing is true of elm, but in a lesser degree. Beech rots very easily if exposed to the elements, but under shelter remains sound. If covered by water, it will remain sound for a long time. Oak, if exposed to the weather, loses its sapwood, but the old wood remains sound for many years. I believe all young timber should either be put in water immediately after it is cut or put under shelter, as the young wood begins to rot very quickly if it is alternately wetted and dried. It follows, then, that deterioration takes place to a far greater extent than we imagine by letting young trees lie out in all weathers with their bark on, as they cannot resist wet without having been first dried. In my opinion, all wood should be either put into water immediately after being cut, or at least when spring comes, as it is absolutely necessary that all timber should be water-soaked before any attempt is made to dry it. It is a well established fact that boards dry much quicker if the logs have previously lain in water. Another fact worthy of record is that water-soaked lumber is never attacked by insects, and hence plank treated in this way can stand for many years without injury.

Regarding liability to absorb moisture, there may be diverse views, as some assert that even paint does not exclude moisture. I hold the other view, and believe that thoroughly seasoned wood properly painted is impervious to moisture. But I likewise believe that the climate of England is such that no wood can be properly dried here except by artificial means. You may build carriages here that will show no sign of a joint, but the same carriage in a climate like Canada, India, or Australia would either fall to pieces or bring discredit upon the builder. This is not the fault of the workman, but because your climate is a damp one. I will even venture to make an assertion, and affirm that it is my belief that a carriage built of seasoned wood in December runs the risk of showing its joints the next August. My remedy is both simple and effective. Let all wood be dried by artificial means. In Canada all our best manufacturers use some kind of artificial means, the simpler one being a closed room with a stove in the center, and the boards or other wood piled, with spaces between, around it. A process lately patented in Canada and the United States dries wood so expeditiously and effectively that it has already revolutionized the building of Pullman palace and other cars. I need scarcely say that these cars are very highly finished. By the above process green wood in a few days can be so thoroughly dried that it becomes suitable for the building of these superb coaches.

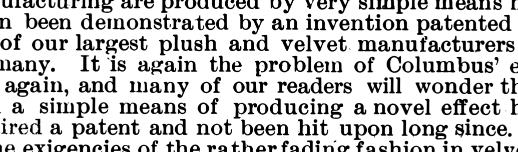
In speaking to an English audience composed of practical men in the highest sense of the term, I feel bound to show that the superiority of your woods does not consist in an inherent quality, but owing to your superior mode of treatment, and I simply ask you to give our woods the same chance you give your own, and I have no fear for the results.

Mr. G. N. Hooper, the president of the Institute, said that the woods obtained from our colonies and many foreign countries were wild, and had grown without attention or care. Much of the timber he had seen growing in Canadian and European forests was of so low a quality as to be only fit for fuel, and he thought he could safely say nowhere had he seen so good and fine an average of timber suitable for carriage building as in England. In England the trees were rarely grown in forests, but in hedgerows, groups, and sometimes singly, and consequently, having plenty of light, air, sunshine, storm and rain, they became hard and tough. Forest trees, being grown close together, did not enjoy these advantages in an equal degree. Timber trees could be cultivated and improved in quality, just as by cultivation flowers and fruits could be improved. The establishment of high schools and elementary schools of forestry in England and her colonies would render excellent service to land owners, as well as to manufacturers requiring sound and fine woods for their work.

PLUSH WITH A WAVED SURFACE.

That many of the most effective improvements in manufacturing are produced by very simple means has again been demonstrated by an invention patented by one of our largest plush and velvet manufacturers in Germany. It is again the problem of Columbus' egg over again, and many of our readers will wonder that such a simple means of producing a novel effect has required a patent and not been hit upon long since.

The exigencies of the rather fading fashion in velvets and plush has brought to light many fancy arrangements of these interesting fabrics, an immense surface being one of them. The manufacturer in question, whose experience in this material extends, if we mistake not, over a very long time, has hit upon a very simple means of producing, without the assistance of cropping or pressing machines, a wavy surface to any desired pattern, which at the same time has all the regularity and exactness of any fancy pattern. To produce this effect in plush or velvet, he uses the ordinary looms, weaves in the usual way, but employs different wires than ordinarily. We show in Fig. 1 a wire of a certain



pattern which has been adopted, and from which it will be seen that a great variety of patterns can be produced, according to the shape of the wire. In this case a simple wave line was desired, and this outline has been given to the under side of the wire, A; the upper surface contains as usual the groove for the guidance of the cutting knife. By inserting these wires into the tissue as the weaving proceeds, the latter will attain on its under side—viz., the backing of the velvet or plush—the shape of the under side of the wire, while the upper part of the pile is level, as shown in Fig. 3, D being the pile, B the backing, and A the wire. As the wires, one by one, are withdrawn after the cutting of the pile, the backing of the tissue, in consequence of its tension, will rise to a level and force the pile in a waved line upward, as is seen in Fig. 2. There is thus no cropping required, as the waved line is perfectly regular and even.—*Textile Manufacturer.*

BUTTER COLORS.

By Prof. H. B. Cornwall.

Several of our States have forbidden the addition of coloring matter to butter substitutes in imitation of the yellow color of genuine butter, so that our chemists frequently have to make tests for such added colors.

Not one of the published methods tried by the writer gave much satisfaction. Some failed to extract coloring matters known to have been added, others gave emulsions which were entirely useless for examination, and the writer consequently tried to find some better method.

The following gave perfect satisfaction so far as regarded the separation of annatto, which is the chief ingredient of every commercial butter color met with by the writer:

About 5 grms. of the warm filtered fat are dissolved in about 50 c. c. of ordinary ether, in a wide tube, and the solution is vigorously shaken for ten to fifteen seconds with 12 to 15 c. c. of a very dilute solution of caustic potash or soda in water, only alkaline enough to give a distinct reaction with turmeric paper, and to remain alkaline after separating from the ethereal fat solution. The corked tube is set aside, and in a few hours, at most, the greater part of the aqueous solution, now colored more or less yellow by the annatto, can be drawn from beneath the ether with a pipette, or by a stopcock below, in a sufficiently clear state to be evaporated to dryness and tested in the usual way with a drop of concentrated sulphuric acid.

Sometimes it is well to further purify the aqueous solution by shaking it with some fresh ether before evaporating it, and any fat globules that may float on its surface during evaporation should be removed by touching them with a slip of filter paper. But the solution should not be filtered, because the filter paper may retain much of the coloring matter.

The dry, yellow, or slightly orange residue turns blue or violet blue with sulphuric acid, then quickly green, and finally brownish or somewhat violet (this final change being variable, according to the purity of the extract).

Saffron can be extracted in the same way. It differs from annatto very decidedly, the most important difference being in the absence of the green coloration.

Genuine butter, free from foreign coloring matter, imparts at most a very pale yellow color to the alkaline solution. But it is important to note that a mere green coloration of the dry residue on addition of sulphuric acid is not a certain indication of annatto (as some books state), because the writer has thus obtained from genuine butter, free from foreign coloring matter, a dirty green coloration, but not preceded by any blue or violet blue tint.

Blank tests should be made with the ether. But it is easy to obtain ether that leaves nothing to be desired as to purity.

Turmeric is easily identified by the brownish to reddish stratum that forms between the ethereal fat solution and the alkaline solution before they are intimately mixed. It may be even better recognized by carefully bringing a feebly alkaline solution of ammonia in alcohol beneath the ethereal fat solution, with a pipette, and gently agitating the two, so as to mix them partially.—*Chem. News.*

FILTER PRESSES FOR SEWAGE SLUDGE.

At a recent meeting of the Institution of Civil Engineers, London, a paper was read on "Filter Presses for the Treatment of Sewage Sludge," by Mr. William Santo Crimp, Assoc. M. Inst. C. E., F.G.S.

The author observed that in breweries, sugar factories, sewage precipitation and other works, large quantities of semi-fluids, or of fluids containing varying quantities of solid matter held in suspension, were produced, and it was often necessary to separate the solids from the liquids. This object might generally be attained by filtration, either natural or mechanical, or by evaporation. In the case of sewage works, where chemicals were the agents for precipitating the solids, difficulties had arisen from the large masses of sludge to be disposed of being in a sloppy and very offensive condition. Engineers had, therefore, endeavored to effect a reduction in the quantity, by getting rid of as large a portion of the liquid as possible. The earliest method tried was that of exposing the sludge to the atmosphere in specially constructed filters. At Wimbledon, filters had been constructed of screened town ashes carefully underdrained, and to further aid in the desiccation of the glutinous mass, more ashes were mixed with the sludge. During the winter, however, evaporation was feeble. The author found that after exposure, between September, 1883, and March, 1884, the sludge still contained 77·5 per cent. of moisture, and was very offensive. In hot dry weather, although the sludge dried more quickly, there was much more risk of creating a nuisance, unless the material was plowed into the ground, as at Birmingham, in its fresh condition, a method which was inapplicable in many cases. In towns of only moderate size, large areas were required for the exposure of the material, and this gave rise to a nuisance after a few days' exposure, unless the works were remote from dwellings and highways. Machines had at various times been introduced for drying sewage by the application of heat. But as sewage sludge contained in its normal condition 90 per cent. of moisture, the cost of fuel had prohibited the use of such apparatus. Milburn's drying machine, for instance, was stated to have been tried at Oldham by the Carbon Fertilizer Company, when 1 lb. of coke evaporated 6·80 lb. of water. Thus, in order to reduce 100 tons of normal sludge to 20 tons with 50 per cent. of water, about 12 tons of fuel would be required.

The paper dealt more particularly with the filter press as now adapted to this purpose. Filter presses had been employed at Wimbledon during the last two years. The present weekly production of sewage sludge at Wimbledon was 250 tons, and this quantity was reduced by means of two of Johnson's filter presses to 50 tons of sludge cake, containing 50 per cent. of moisture, at a cost of 2s. 6d. per ton, for labor, lime, fuel, cloths, etc., to which should be added interest on the original outlay, and depreciation, equal to 1s. per ton more. The precipitation of the matters held in suspension in the sewage was effected by lime and sulphate of alumina, the average quantity used daily being, for both pressing and precipitating, equal to 0·91 ton. It had been ascertained that the quantity of solids which would be produced, if the moisture were all evaporated, would be equal to 1 ton weekly for 1,000 persons. In the case of the metropolis, assuming the population draining to the outfalls to be 3,800,000, the amount of pressed cake produced daily, calculated upon this basis, would be 1,086 tons, or 186 tons in excess of the estimate of the Royal Commissioners on Metropolitan Sewage Discharge. The actual quantity would doubtless be less in consequence of the small quantity of lime used. But, on the other hand, the road detritus must form a considerable portion of the solids in wet weather. Taking the amount at 1,000 tons daily, the annual cost of pressing would, in the opinion of the author, amount to 45,000*l*. exclusive of the charge on capital account. In consequence of the proximity of Wimbledon to the metropolis, where enormous quantities of stable manure were produced, some difficulty was experienced in selling the sludge, although the experiments of the author, which had been confirmed by Professor Munro, of the Royal College of Agriculture, Downton, proved that the pressed sludge was of more value than stable manure of good quality.

In the author's experiments, sludge cake was tried with superphosphate and with farmyard manure, the crops grown being hay, potatoes, mangolds, cabbages, and swedes, the average production per acre being in the case of sludge cake 13·15 tons, superphosphate 12·60 tons, and farm yard manure 12·27 tons, while the

unmanured plot yielded 11·72 tons. Potatoes were especially benefited by the dressing of sewage sludge.

The conclusions arrived at by the author after careful observation of the filter press during the past two years were that the machine afforded a ready solution to the question of the disposal of the sloppy mass of putrescent mud produced daily in sewage precipitation works, that the offensive and useless masses might be quickly converted into a practically inodorous manure, and that the manure was superior to ordinary farm-yard manure.

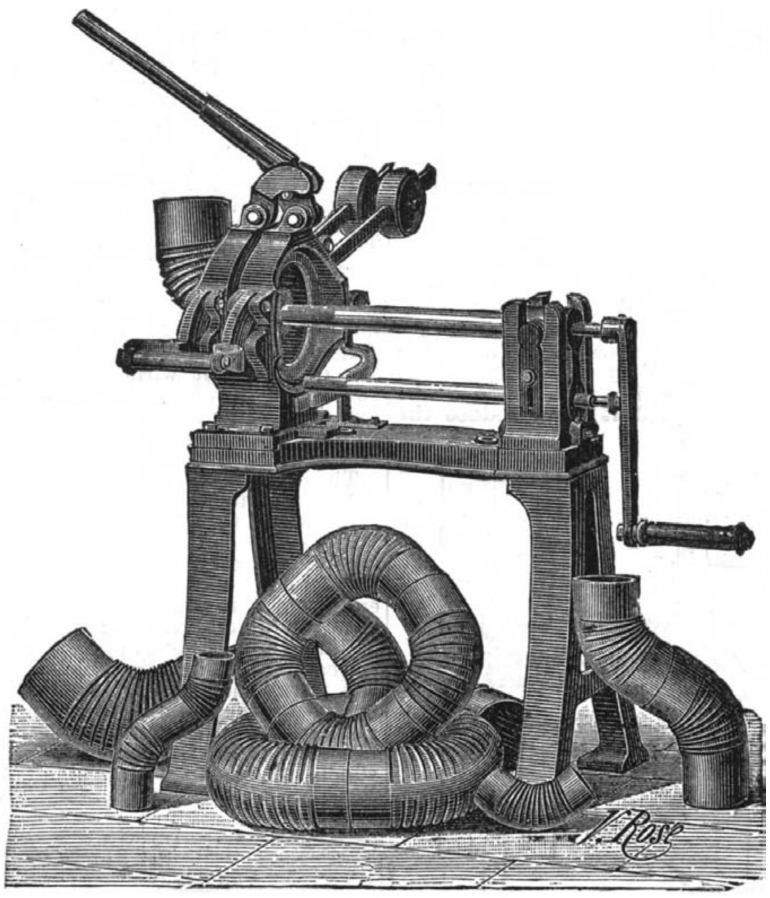
MACHINE FOR ELBOWING SHEET IRON PIPES.

THERE are several kinds of machines employed for bending and corrugating sheet iron pipes, and the favorite is the one based upon the Bertram apparatus, which is now public property. Despite the service rendered by this tool, it is not free from drawbacks. It requires practical and strong workmen to run it, and

The four shells are movable in pairs, either for the opening of the end by shoving the upper shell backward, or for bringing the two collars together laterally, and each of them is provided internally with a semi-circular plate forming a bearing upon the two sides of the eccentric disk.

The pipe, which has been previously riveted at a single point of one of its extremities, is corrugated and bent as follows: A double ring is first slipped on each end to keep the pipe in shape. Then the upper jaw is pushed back by means of the handle shown in the engraving. This operation, on account of the two counterpoises, requires but little effort.

When once the pipe has been inserted in the former, the system of shells is closed and the winch is turned. The eccentric forces the metal into the interval left free between the semicircular fittings of the collars, and after an entire revolution a pressure is exerted on the cam lever that surmounts the collars, in order to form the corrugations in the pipe. When the lever is freed, the collars automatically regain their former position.



MACHINE FOR ELBOWING SHEET IRON PIPES.

its high price prevents its introduction into many shops. Besides, each Bertram machine is capable of shaping a pipe of uniform diameter only, hence the necessity of procuring a costly and cumbersome stock of apparatus if it be desired to manufacture elbows of all the sizes used.

Messrs. Brand & Co. have devised a machine that completely revolutionizes this mode of manufacture, and that is distinguished from the preceding in that it will receive a pipe of any diameter whatever, limited only by the power of the tool. To this characteristic feature must also be added the automatic formation of the elbow by the very fact of the corrugating.

Some experiments, at which we were present, appeared to us to be very conclusive, and this is why we feel it incumbent on us to publish a description and illustration of the machine.

Upon the shaft, on the side opposite the winch, there is a metallic former consisting of two loose pieces, between which is eccentrically keyed to the shaft a disk with rounded edge. The thickness of this disk determines the width of the corrugation to be made in the pipe, while its degree of eccentricity regulates the height of it,

The former occupies the center of a device consisting of two shells. In the lower shell adjoining the frame there is a hinge that connects it with the upper shell. Each of these half segments is divided transversely in its center so as to form two vertical collars, placed side by side and so arranged that the one on the left forms one with a bed plate that carries a hinge for the collar to the right.

Moreover, the interval between them increases, while the back of the apparatus is being opened, by reason of the tendency that the collar to the right has to revolve on its transverse hinge. A sliding stop screwed to the frame of the machine regulates the interval just mentioned, according to the diameter of the pipe to be corrugated.

When the back of the apparatus is opened, the eccentric rises automatically. To this effect, it is provided at the back with a tappet that actuates a bent lever that extends under the rod parallel with the shaft. These two axes are connected by a vertical rod placed in the vicinity of their common support, so that the maneuvering may not be interfered with. The result is that the raising of the rod, through its lever, causes the eccentric to disengage itself from its bearings. The workman pulls the pipe toward him in order to bring the first corrugation into a channel in the interior of the shells. The latter are then closed, and the operation is proceeded with in order to form thirteen or fourteen corrugations, whose spacing is regulated by the machine, and is always the same for each diameter. It is important to add that the elbow is formed automatically during the forming of the corrugations; for, under the actions of the eccentric, the sheet iron contracts more on the upper periphery than on the lower. Consequently, the pipe bends progressively in measure as the work advances. If need be, the right angle may be finished by inserting in the pipe a cylinder of wood provided with a handle, and then exerting a pressure on the latter while the pipe is fixed in the shells.

If one had twenty matrices at his disposal, he might make as many elbows of different sizes on the same machine.

With a little practice one workman can manufacture twenty sheet iron elbows or thirty zinc ones per hour with this machine.—*Revue Industrielle.*

THE STEAMER GREAT EASTERN.

THIS steamship, which for more than a third of a century has remained the largest ever constructed, was designed, about 1853, by the distinguished engineer Brunel, for the trade between England and Australia. It was calculated that a ship could be built having sufficient capacity to carry enough coal for the round trip in addition to a great many passengers and a paying cargo. She was built by J. Scott Russell at his works in Millwall, London, and was ready to be launched in November, 1857, but could not be moved until the following January. Even that early in her history her unlucky star assumed the ascendency, and in all her subsequent wanderings seemed ever present.

When launched, her cost was $3,831,520.

The Great Eastern is 692 feet in extreme length, 83 feet beam, and 27,000 tons actual capacity. She was built of iron, and double cased to about three feet above the water line. The motive power consisted of eight engines, four for the paddle wheels, which were 56 feet in diameter, and four for the screw, 24 feet in diameter. The cylinders of the paddle engines were 74 inches in diameter by 14 feet stroke; and those of the screw were 84 inches in diameter and 4 feet stroke. The heating surface of the boilers supplying the paddle engines was 44,000 sq. feet, while that of the screw engine boilers was still larger. The united nominal horse power was 4,000.

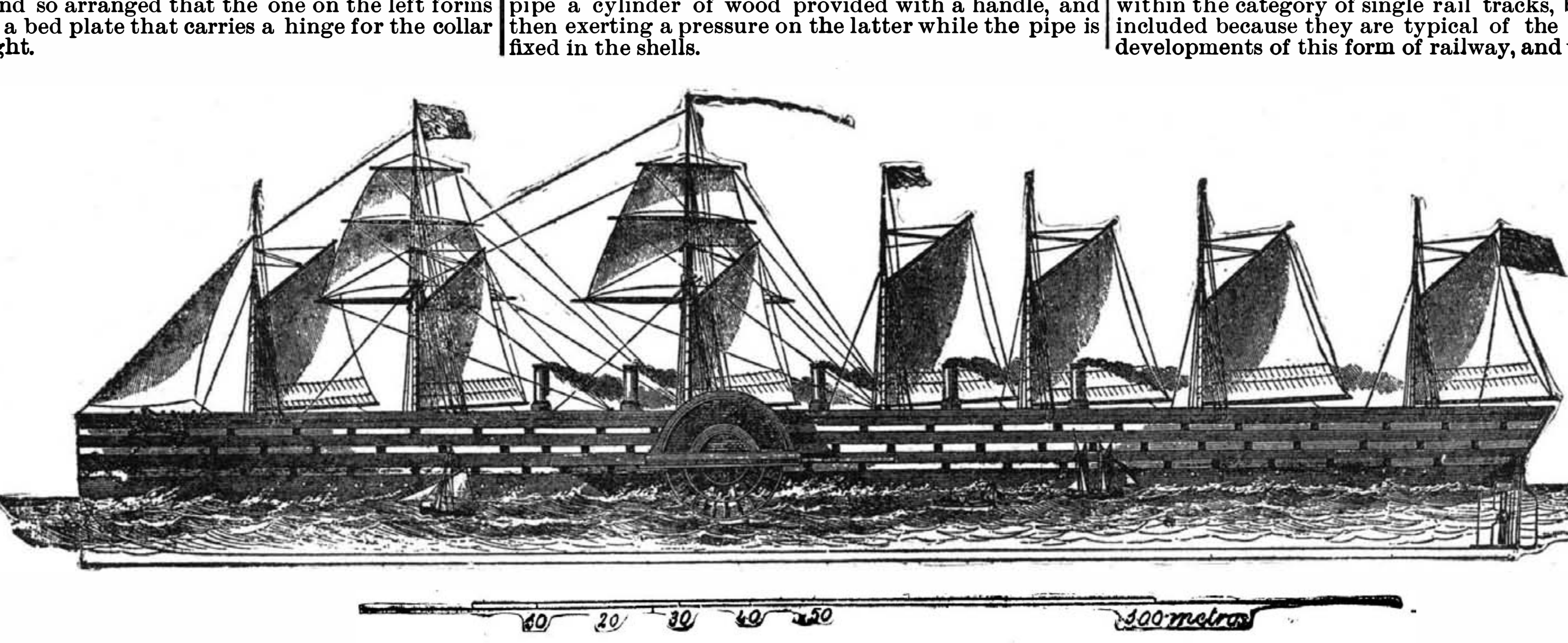
The first voyage to New York was made in 1860, and during the voyage she nearly averaged 336 miles per diem, or 14 miles per hour. Steam was carried at a pressure of from 15 to 24 pounds, and the total quantity of coal consumed was 2,877 tons. Since then her history has been strange and eventful, and the opinion we expressed in our issue of July 7, 1860, upon her visit to New York, has been most peculiarly borne out by the facts: "Although we cannot but regard the Great Eastern as a failure in *payability*, yet she is not so in a scientific sense. She is a grand experiment."

This ship, which, notwithstanding the many hard knocks she has received, seems to be in almost as good condition as when launched, now attracts attention because of the new use she is to be put to. For some time she has been exhibited at Liverpool, and has lately been taken as a "show ship" to Dublin. It is to be hoped that this venture will prove more remunerative than former ones; it certainly should, since the vessel is well worth a long journey to see, and a critical examination of her hull and machinery cannot fail to be both instructive and interesting. It is to be hoped that those in charge will brave the dangers of the Atlantic, and bring the leviathan once more to this country.

The Great Eastern was lately sold at auction for the sum of $130,000.

SINGLE RAIL RAILWAYS.

LIKE the poor, the single rail railroad is always with us, and every few years it appears in some more or less fresh shape, and for a time attracts a good deal of attention. At present two schemes are before the public, and as these appear in a much more serious form than any of their predecessors, it is worth while to trace the history of the idea upon which they are founded, and to discuss the sphere of action in which they can be usefully exploited. The first record we have on the subject of a single rail line refers to a proposal in 1821 by Henry Robinson Palmer. In this the rail was mounted on a horizonal wooden beam supported on a line of posts (Fig. 1). The carriage had two wheels, one behind the other, and between them was a cross yoke, from either end of which was suspended a pannier carrying half the load. As shown in the diagram, the center of gravity was high, and the carriage must have had very little stability when unloaded. Four years later, 1825, Jacob Jedder Fisher took out a patent for a suspended railway, in which the weights were carried below the rail. In his drawings he shows the tracks carried across a stream by a suspension bridge (Fig. 2). Another suspended line was also patented in 1829 by D. Maxwell. In 1845 Mr. William Newton patented a track in which two horizontal wheels ran on either side of a rail of ordinary section (Fig. 3); and the following year Mr. Robert J. Clinton described a central rail railway, with the middle line (Fig. 4) elevated above the others. Sir Samuel Brown also patented (1846) a central rail line (Fig. 5) with a grooved wheel on the middle rail. These three latter designs scarcely come within the category of single rail tracks, but they are included because they are typical of the most recent developments of this form of railway, and were the out-



THE STEAMSHIP GREAT EASTERN.

come of the same idea. They were brought out about the time that the battle of the gauges was being fought, and when it was a matter of dispute whether a narrow gauge train could be run with safety on a curve except at slow speeds. The broad gauge had so many distinguished advocates that it is no wonder that attempts should have been made by the less confident spirits of the opposite party to seek lateral stability for their trains by means of an extra rail, which should act as a guide and a security against derailment.

In America we find inventors pursued the same idea. In 1825 Henry Sergeant patented the scheme illustrated in Fig. 6, and which is almost identical with Palmer's design (Fig. 1). In 1830, J. Stimpson brought out a similar arrangement (Fig. 7), with the addition of side strips on the posts. We do not know if these strips served any purpose in connection with the load, but it is probable that they were intended to prevent it fouling the posts if oscillation were set up, or one side were more heavily laden than the other. In the following year, Bryant and Hyett patented a similar design, and in their drawings showed a carriage on the line (Fig. 8). It is only by the employment of a great quantity of ballast that the stability of the carriage could be secured. J. Richards patented a similar arrangement in 1832. Five years later, U. Emmons attempted to give lateral stability to a carriage running on a single rail by the use of two guiding rails (Fig. 9), one at each side of the posts which carried the principal rail. This was a step in advance of what had already been done, but the appearance of his drawing would not give the impression that he was an engineer. We may pass over all the schemes of many succeeding years, until we come to that of E. Crewe (Fig. 10), which was patented in 1872; this had inclined guiding wheels, but in other respects it exhibits strong resemblance to the plans shown in Figs. 8 and 9. At the Centennial Exhibition, again (1876), General Le Roy Stone exhibited a line in action elevated on posts 35 ft. high. It had three rails (Fig. 11) arranged at the three angles of a triangle; the center rail carried the weight, and the other two acted as guides to horizontal wheels, fixed to the two lower arms of the car. The line itself was built over the Belmont Ravine, and was 500 ft. in length. Fig. 12 shows the Cameron pontoon cart which has been proposed for South Africa. It runs on a line of hollowed half logs, pegged into the ground, and forming a track for a single wheel carrying a basket with arms at each side. The equilibrium of the vehicle needs to be sustained by men or animals.

These are a few of the most prominent examples of single rail railways which have been put before the public until within the last few years, with the exception of the Pioneer line proposed by Mr. Haddan. Owing to the decease of the inventor in 1880, this project has slept, but we understand it is about to be revived by a Scotch firm. The essential feature is that every wheel is a driver, and by this means a train may be made to carry 50 per cent. of paying load up steep inclines. The load is also distributed over a large number of wheels, in order that the road may be very lightly built. More recently, however, two inventors have gone beyond the paper stage, and have presented their plans for the acceptance of the public on a scale and with a persistence which compels serious attention. The first scheme is that of Captain J. V. Meigs, of Lowell, Mass. This was illustrated and described in *Engineering*, vol. xl., page 586, and a very short account of it will recall the general features. In the first place, it is not, properly speaking, a single rail line, but as it is a development of that system, it may fairly be classed with it. There are four rails, two for carrying the weight and two for guiding the train. These four rails are fixed to a girder of wood or iron, the former two being on the lower member, and the latter two are on the upper. The bearing rails are angle irons, and the wheels are grooved to correspond, and stand at an angle of 45 deg. to the horizontal. Their axles are, of course, similarly inclined. The guiding wheels, which, in the case of the locomotive, are also driving wheels, are arranged horizontally and run on rails of ordinary section. They can be nipped tightly together in order to give the necessary adhesion. The horizontal distance from outside to outside between the lower rails is 22½ inches, and the corresponding gauge of the upper rail is 17½ inches. The carriages are almost circular in cross section, and are made of sheet iron; they are long, with entrances at the ends, and each is mounted on a bogie truck at each end. By this arrangement there is obtained a roomy carriage which is able to turn round very sharp curves. The primary object of the Meigs system is to produce a railway suitable for the overhead lines which are in use in New York. That system involves so many inconveniences to those dwelling in or frequenting narrow streets that any alteration which promises to interfere less with the traffic, and with the light, than the existing arrangement is worthy of attention, even if the gain involve disadvantages of a mechanical kind. Of course the advocates of the Meigs system do not admit that it has any countervailing disadvantages; they claim that it is not only better, safer, and cheaper than the existing New York elevated roads, but that it is adapted for passenger and goods transport from town to town at a higher speed and cheaper rate than the present lines. With this latter point we shall deal later, when we come to speak of the Lartigue railway, and will pass it over for the present. As to the former, we can conceive it possible that there may be situations in which the small space occupied by the narrow track will offer advantages over the standard gauge. It is erected on a single row of posts, and is only about one-third of the usual width, so that the obstruction to light and air is greatly reduced; the trains can pass round exceedingly sharp curves, and there is an appearance of safety which is comforting to passengers. The guiding rails afford a means of braking which is most powerful, and put the train under perfect command. These advantages may, under certain circumstances, be sufficient to recommend the Meigs railway for overhead traffic, but they are obtained at the expense of many serious mechanical difficulties, and some awkward strains on the framing, which cannot fail to produce oscillations of a startling character. The design has, however, been worked out by capable engineers, and, under certain conditions, it could, no doubt, be made a success, and, if adopted, it might reduce the dissatisfaction which the overhead railways so often provoke.

Among single line railways, we should also include those of M. Larmanjat, of which examples were constructed in France about seventeen years ago, and a little later in Portugal. A description of M. Larmanjat's plans appeared on page 354 of our ninth volume. In this arrangement the carriages ran on a single rail on the road level, like a string of tight-rope dancers. As, however, they had not the faculty of balancing themselves on their central wheels, they were provided with supplementary wheels at the sides. These wheels had no flanges, and were situated over two wooden tracks which prevented the carriages from overturning. Practically, the wheels on one side only bore at a time, the loading and the centrifugal force determining to which side the list should take place. The locomotive had also central and side wheels, but in its case the side wheels, which were the drivers, carried the load, the central wheels acting as guides, the object being to secure greater adhesion than that obtainable on an ordinary rail. M. Larmanjat's schemes at one time received considerable financial support, among others two lines of some importance being built in the neighborhood of Lisbon. Practically, however, the arrangement was an utter failure, and so far as we are aware, the Larmanjat lines have all ceased to exist long ago.

We now come to the most recent scheme, the Lartigue railway, of which a large working model is at present in operation on a piece of vacant ground beside the fire station in Victoria Street, Westminster. A single line railway has also been erected and worked by M. Lartigue in the sandy wastes of Algeria. This is similar in principle, although not in detail, to the line shown in Fig. 13. A light iron rail is mounted on iron trestles of a shape like an inverted Y (⅄), and on the rail run grooved wheels mounted in a frame which depends on each side and forms panniers for the reception of bundles of esparto grass. About 80 miles of this has been erected, and has, we believe, done good service. The trains are drawn by mules, and the track is shifted every few months to follow the progress of the crops. There is also a line of more ambitious kind at the mines of Ria in the Pyrenees Orientales. This is 6¾ miles long, and is over a most difficult piece of land, with inclines of 1 in 12, and curves of 10 ft. radius. An experimental full-sized line has also been built in London, as stated above; it is constructed on two scales, part being a lightly built portable track, and the remainder a permanent passenger road. Of the main line, one-half is practically on the flat, and will serve principally for experiments on speed and for determining the consumption of fuel and water. The remainder is an irregular line, having curves of 50 ft. radius and inclines of 1 in 10. Upon the level piece there is a turntable which connects with the carriage shed by a line including a curve of 32 ft. radius. There is also on the line a wooden viaduct 340 ft. in length, laid at an incline of 1 in 10 to the summit, and then at 1 in 34 till it again reaches the level. On the steeper portion a rack is laid, to gear with a supplementary machine which assists the engine at this part of its course. Another feature is a three-throw switch, by which the train may be directed along the main line, or diverted to either of the side tracks. The line consists of a single rail, something similar to an ordinary rail in section, supported upon and bolted to A frames of angle iron 1 meter in height. These frames are riveted to channel iron ties 1 meter in length, resting on the ground. The rail is ordinarily 1 meter from the ground, and the frames 1 meter apart. The way is designed to be very stiff vertically, in order to support this load without springing, but flexible laterally to allow of being easily bent to a curve. The ties are secured for endwise movement, when there is chance of their slipping, by long pegs driven into the ground through holes in the metal. The rails are connected by fishplates in a way which permits of their being easily taken apart. The plates are bolted solidly to the end of one rail in the usual way, but the end of the contiguous rail has its bolt holes cut through to the bottom side to form slots. When the bolts are slackened, this rail can be lifted out of the joint without removing the nuts. The switch consists of a section of the way 23 ft. in length mounted upon rollers. One end is hung loose in the fishplates or upon a hinge, and the other is locked by a tongue latch and pin.

The carriages as built for the Westminster track are made short, to allow them to pass easily round curves as small as thirty feet radius. They and the goods wagons are alike nine feet in length. A cross-section of a carriage is shown in Fig. 13. The framing is composed of stiff angle-iron bars at each end, bent into a horseshoe form in order to fit and clear the rail and trestles; the ends are bent outwardly and horizontally, to support the framing and floor of the carriage. The part which is parallel with the trestles forms the back of the seats, and leaves room beneath for the running gear, which consists of two grooved supporting wheels, running on the rail. At the sides of the trestles, just beneath the car framing, which extends to within about 15 in. of the ground, there are stiffening strips of light bar iron, upon which four horizontal balancing wheels, flanged on their lower sides, run. These are mounted on the carriage framing, and are designed to secure it against oscillating. The horseshoe bars on either side are connected by horizontal bars which carry the body framing covered with panels of wood or sheet iron. The carriages are provided with ordinary couplings and buffers, and the goods wagons are also furnished with a shifting seat, which can be brought into service when required.

The locomotive is the design of M. Mallet. It has two vertical boilers, arranged one at each side of the central rail. The steam and water spaces of these two boilers are connected by tubes which bridge the rail, and the whole is supported by a framing something like that of the carriages, resting upon two grooved wheels 15 in. in diameter. The engine has horizontal cylinders 4½ in. in diameter, working on to the driving axle, and is driven and stoked by a man on a seat astride of the rail. The weight of the locomotive, in working order, is about 2½ tons, or 1¼ tons on each axle. With steam pressure of 100 lb. per square inch it will have a speed of five or six miles an hour, hauling 70 tons on the level, 18 tons on an incline of 1 in 100, 9 tons on inclines of 1 in 50, and 6 tons on an incline of 1 in 34. With smaller loads a speed of 10 or 15 miles an hour may be obtained, and the engine will pass round curves of 30 ft. radius. For lines requiring greater power than this, larger boilers and more supporting wheels are required. In that case there are two horizontal boilers of the locomotive type provided with steam domes and connected by pipes, the water tanks being below the barrels of the boilers. This engine has three coupled wheels, and weighs about 4 tons. The center wheel is made wider between the flanges than the others, or has no flanges, to allow the engine to pass readily round sharp curves. It will draw 100 tons on the level, 50 tons on an incline of 1 in 100, 25 tons on an incline of 1 in 50, and 18 tons on an incline of 1 in 33. Another engine with four coupled wheels has been designed, weighing about 5 tons; the leading and trailing wheels are connected to their axles by a gimbal arrangement to permit of their following the sinuosities of the rail.

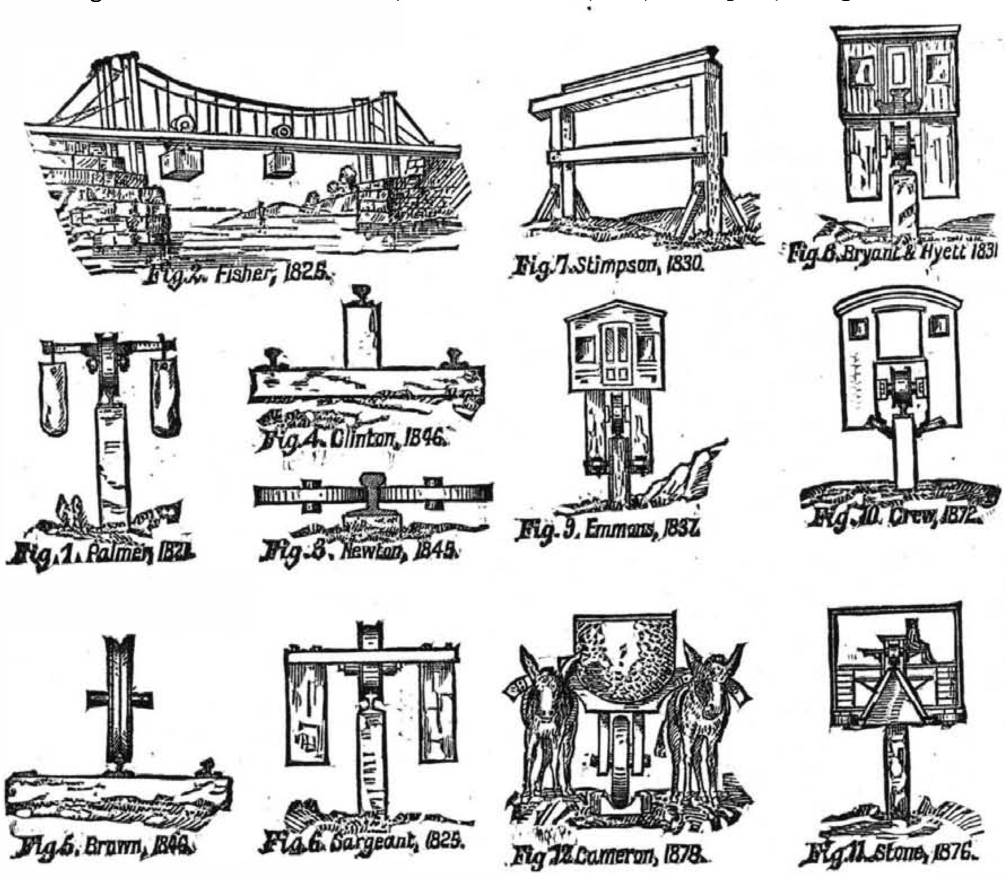


Fig. 2. Fisher, 1825. Fig. 7. Stimpson, 1830. Fig. 8. Bryant & Hyett 1831. Fig. 4. Clinton, 1846. Fig. 1. Palmer, 1821. Fig. 3. Newton, 1845. Fig. 9. Emmons, 1837. Fig. 10. Crew, 1872. Fig. 5. Brown, 1849. Fig. 6. Sargeant, 1825. Fig. 12. Cameron, 1878. Fig. 11. Stone, 1876.

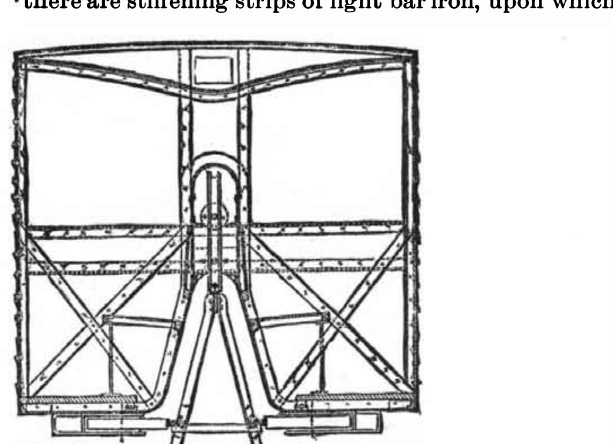


Fig. 13. Section showing Iron Framework of Carriage.

SINGLE RAIL RAILWAYS.

For mounting inclines too steep to be attempted by the simple adhesion of the locomotive, an auxiliary machine, to work upon the rack rail, is in use at Westminster. It is a very short vehicle, 3 ft. 10 in. long, containing a steam cylinder which drives a spur pinion engaging with the rack rail, the steam being supplied from the locomotive boiler by means of a flexible tube. This machine, weighing only 11 cwt., has a tractive power of 1000 lb., which would enable it to take a load of 4 tons up an incline of 1 in 10. In descending heavy gradients its cylinder may also be used as a compressed-air brake.

The entire ironwork of the line at Westminster weighs but 70 tons per mile, the rail being 23 lb. per yard, the side rails 11 lb. per yard, and each complete trestle 12½ lb. The locomotive weighs about 2 tons empty; the auxiliary machine, 11 cwt.; the first and second class carriages, 18 cwt. each; and the open goods trucks, less than 1½ tons each. The portable line, which is part of the railway constructed in Tunis, weighs 18 tons per mile complete. The permanent line, including all material ready for laying, is said to cost 6000*l.* per mile, and the portable line about 300*l.* per mile. A permanent line 10 miles long, in Ireland, has cost, including equipment, about 22,000*l.*, or about 2200*l.* per mile. For farming purposes the materials of a line weighing between 14 and 15 tons per mile can, it is said, be built for 220*l.* per mile, bolted together ready for use and delivered by rail. The trucks weigh 170 lb. empty, and when loaded to a height of about 6 ft. from the ground, will carry about one-third of a ton of hay or other cereal. A train of twenty-five of these trucks can be drawn by one farm horse, or at least eight times as much as he could otherwise deal with over agricultural land.

Having now described the leading features of the Lartigue railway, and the estimated cost of its manufacture, we will turn to consider the advantages it presents or which are claimed for it. Of course, one naturally compares this line with a cheap form of narrow gauge railway, such as those now manufactured by so many firms both in this country and abroad, as it is with lines of this type that it competes. In the country of its birth, the deserts of Algeria, the elevated rail enjoys a notable advantage in being well raised above the drifting sand. It stands 3 ft. 3 in. clear of the ground, and a sand storm which would effectually bury an ordinary line makes no difference to its traffic, which can come and go with the same facility as before. The same is true as regards snow drifts, and in countries where these two impediments to working prevail, the Lartigue railway has at least one point of superiority over a surface track. The feature, however, which appeals most strongly to the public is its safety against derailment. At the first glance, a train which sits astride of the rail, like a boy on a gate, should be absolutely proof against running off the line, and thus it offers an attraction to the nervous traveler. But the immunity it presents for this class of disaster is, we fear, more apparent than real. Although the vehicles cannot diverge from the rails, yet it is within the bounds of possibility that the wheels may, and then the results would be sufficiently calamitous, for the engine would be certain to foul some of the trestles, with the effect or bringing the whole train on to the ground and piling it in a confused heap. Even if the Lartigue railway could promise absolute immunity from derailment, the advantage would not be of much importance. It may be laid down as an axiom that on a properly laid and kept railway, trains never leave the metals; and when such an accident does occur, it generally can be traced to some mechanical defect which might and ought to have been remedied. If the roadbed is badly made, and is allowed to get out of repair, accidents are certain to happen under any system, even under the Lartigue, and none but those who are acquainted with the care demanded by an ordinary line can realize what trouble will have to be expended on an elevated railroad. If the ballast gets away a little from under an ordinary sleeper it does not very greatly matter, but it will be a very different affair when the rail is mounted on a post 3 ft. high in its center. Fancy the effect of a train passing at 20 miles an hour after heavy rains over a line of this kind with the sleepers one meter apart. It will surge from side to side as the sleepers give way under its weight either to right or left, and would intensify the mischief so rapidly that the track would speedily become impassable, and not even could a ballast train be brought up to aid the repairs. The oscillation would also be increased by the unequal loading of the passengers. It would often happen that one side of the car would be filled while the opposite side would be entirely empty, and thus the entire load would come on one flange of the wheel, tending to make it mount the rail on a curve. Nothing but the most careful track laying and the most vigilant inspection could render the Lartigue railway safe in wet weather; and if a wheel did leave the rail, the consequences would be far more disastrous than on a surface railway.

The elevated single rail seems to have a great charm for the amateur engineer, though it is difficult to see the reason of the attraction. It cannot be that the raised position confers any advantage, for no one has yet proposed to run an ordinary railway on lines of posts rather than on the ground. It certainly gives no immunity against accident, while the facility it offers for the use of curves of small radius is likely to tempt the designer into petty economies of construction which will have to be heavily paid for out of working expenses. The single rail also cannot cost much less than the two it replaces, as it has to stand the same wear and carry the same load over wider spans. The only situations where the Lartigue railway would be of advantage, so far as we can see, are those where an ordinary track would be obscured by drifting sand, or where a mineral line has to be zigzagged down a mountain side with very sharp bends. But for high speeds and general traffic, it is certainly quite unsuited.—*Engineering.*

WORKING OLD STEEL.

MR. E. D. WASSELL, of Pittsburg, has made experiments with a new process for reworking old steel rails into bars from seven to eight inches in width, and also for a new method of working high carbon steel into a low carbon steel, and by the same process to make a perfect and homogeneous weld with steel at any point in carbon. Mr. Wassell claims that steel bars of any carbon can by his process be piled the same as puddle bars and worked into finished products as expeditiously as the puddle bars, and with better results as to finished surfaces. Mr. Wassell reports:

Experiments have been made at different times and in different places which have proved satisfactory to all the parties interested. Further tests have been made lately at the Atlantic Iron Works at Sharon, Pa., and, although made under the most adverse circumstances, yet the results obtained were entirely satisfactory. These experiments were conducted in one of the puddling furnaces, which was located about 100 feet from the rolls. The piles of steel, when taken from the furnace, were conveyed to the rolls in a wheelbarrow, which presumably was the first time a wheelbarrow was ever used for that purpose. There are no reflections intended by these remarks, as the arrangements of the Atlantic Iron Works are complete, and will compare with any other works in their line of manufacture. But the method of conducting the experiments was such that the appliances of the works could not be used, as they were not adapted to any new departure of this kind. The process consists first in reducing the old steel rail to a flat bar, about 7½ inches in width. This is done by the use of rolls, which are peculiar in their form, being designed so as to force the metal in the head and flange of the rail in a direction transverse to the length of the bar, so that, instead of going into the length of the bar, it is thrown into the width, and both the head and flange of the rail is by the action of these rolls brought to a level plane with the web or neck of the rail. The method of rolling an old steel rail heretofore has been to flatten it down to a 4 inch bar. This, on account of there being so much more metal in the head and flange than in the web or neck, causes the latter to wire-draw to such an extent as to make the bar worthless. After the rails are flattened down to 7 or 7½ inch bars they are cut into suitable lengths, and piled in the same manner as puddle bars for nail plate or other forms of finished products. The piles made from the steel bars are then charged into a suitable furnace containing a sufficient depth of molten slag to entirely cover the piles so charged, so as to prevent oxidation of the steel taking place. The steel thus protected from oxidation may be heated to almost any temperature without any injurious effects being produced.

To get satisfactory results in the shortest possible time it is necessary that the slag bath be brought up to the highest possible degree of heat before charging the furnace, as the steel, independent of the carbon it may contain, is capable of undergoing as high a temperature as that under which it may have been made either by the Bessemer process or in the open hearth furnace. Under these circumstances the carbon will be eliminated much sooner. If the conditions under which this process of working old steel rails or steel scrap are right, the time required to reduce a high carbon steel to a low carbon should not be over forty minutes, and it may be done in thirty-five. Then the charge may be drawn from the furnace and rolled down into nail plate or other finished products with the best results in the matter of making perfectly sound and homogeneous nail plate, sheet steel, heavy plate, or anything into which they may be rolled. This method of reworking or treating old steel rails or other steel scrap is in wide contrast to the ordinary method of simply heating the steel rail in the ordinary sand bottom furnace, in which the steel cannot be heated to a higher temperature than a bright cherry red, for if they are the steel is rendered worthless for all purposes except for open hearth use. Steel can be treated by the use of the slag with little waste, as it is impossible to oxidize it if properly covered by the slag, and when rolled down into finished products will carry a better surface for the same reason. The practical tests that have been made at different times have shown that the plates made under the process of treating the steel in a slag bath have been pronounced by practical experts to have a very well finished surface.

The following results in reducing the carbon are reported as the outcome of practical tests made under the supervision of Mr. Wassell. Steel bars containing 0·65 in carbon by analysis made by Messrs. Hunt & Clapp, of Pittsburg, were piled and subjected to the action of the slag bath. The piles were charged into the slag bath cold and were allowed to remain in the furnace 22 minutes, when they were taken out and rolled into scalp steel 6 by No. 10 gauge. A second analysis was made by the same chemists, and the carbon was found to have been reduced to 0·53 per cent. from 0·65. Another test was made with steel bars containing 0·62, and the carbon reduced to 0·47 per cent. Old steel rails containing 0·45 in carbon were subjected to the slag bath for 35 minutes, and by analysis it was shown that the carbon had been reduced 0·25. Steel thus treated has been rolled into nail plate, the nails cut from which have been pronounced high in quality. Sheet steel of No. 26 gauge has been rolled from the bars made under this process which have not shown the least indication of an imperfect weld.

In the matter of output, it can be handled as readily as the steel slab, and reduced by rolling in the same number of passes as are required to reduce a Bessemer steel slab to nail plate. It is claimed that the method of heating will be less laborious for the heater, as the piles do not require to be turned over in the furnace. Less skill will be required in heating, as the charge will be governed by time, and not by the judgment of the heater. It will be a matter of adaptation to the change in the method of heating. When once formed, it will be more easily done than in the ordinary way, and the output as great, if not greater, than by working the Bessemer steel slab. The value of the process will be apparent when it is known that Bessemer steel slabs are worth in the market about $33.50 per gross ton, and old steel rails are worth about $22.50 per ton, showing a difference in cost of what may be termed the crude material of $11, and that to put old steel rails into nail plate will not cost over $2.50 per ton more than to put Bessemer steel slabs into nail plate. The same will apply to any other finished products which may be made under this process, thus showing an advantage of about $8.50 per ton over Bessemer slabs. The process is open for examination as to its merits or correctness both in theory and practice. It is the intention of the parties interested in the patents to dispose of a certain number of rights to a certain number of mills for certain lines of manufacture, not to be less than six nor more than eight mills for the manufacture of nails, reserving certain rights in the patents for their own benefit.

IMPROVED ELECTRO-METALLURGICAL PROCESS.

ECONOMIC TREATMENT OF BLUESTONE AND SIMILAR COMPLEX ORES—ELECTROLYTIC COPPER REFINING—ELECTROLYTIC SULPHURIC ACID MANUFACTURE.

IT frequently happens, in connection with mining industry, that although a mine produces an ore which contains a considerable quantity of metal, it is so difficult to separate the metallic from the non-metallic portions that the realization of profit is altogether impracticable. It is believed, however, that a complete remedy has been found by Messrs. William and A. S. Elmore, the well known electro-chemical engineers, and H. Barrett, who, in dealing with complex ores, such as bluestone and the like—which contain in varying quantities zinc, lead, copper, silver, gold, iron, sulphur, and gangue—they charge the finely ground ores from which the metals are to be extracted into an improved reverberatory furnace, which they work in combination with a fume-condensing chamber and electrolytic apparatus for the manufacture of sulphuric action by electrolytic action. The finely ground ore is "let down" upon the hearth of the furnace, to which there is free access of air, the furnace being at a temperature not exceeding a dull red heat, which is gradually raised to a bright red heat after the charge has been completed, and so maintained until the zinc and copper contents have been sufficiently oxidized. When the calcination is completed the ore is withdrawn from the furnace, and while still hot is transferred to the tubs of a mechanical stirrer or agitator, where it is by the action of the stirrers brought into intimate contact with the water, dilute acid, or other solvent to be used for the solution of the zinc, or for the solution of the zinc and copper together, or for the solution of other metals the ore may contain either separately or together.

When the solution obtained from the washing of the ore contains zinc, copper, iron, and some silver, it is run into settling tanks, where it is allowed to thoroughly settle. From thence it is run into a tank which contains metallic zinc, which metallic zinc will go into solution, replacing the copper and silver, the copper and silver being precipitated in a metallic or semi-metallic state from the solution containing the zinc, the mixed copper and silver being collected, washed, dried, melted, and cast into convenient form and size for use as anode or positive plates in a subsequent electrolytic process for the separation of the copper from the silver contained.

The solution, after this precipitating operation, is, if not too highly charged with iron, run direct into electrolytic decomposition tanks for the purpose of depositing the zinc. If the solution contains an objectionable quantity of iron, such solution, before being run into the electrolytic depositing tanks, should be mixed with or run over or through a sufficient quantity of carbonate of lime to precipitate the iron. It will be found advantageous during this operation to blow or force air or steam through the solution to assist the precipitation of the iron.

When the copper, iron, and silver have thus been eliminated and the solution run into the tanks, they pass a current of electricity from a dynamo-electric machine or other suitable source of electricity through such solution containing the zinc (using lead or other insoluble or practically insoluble material as anodes or positive plates, and thin sheet zinc or other suitable material as cathodes or negative plates), upon which a certain quantity of metallic zinc is deposited at the cathode or negative plates, and a proportionate quantity of sulphuric acid is liberated at the anode or positive plate. This quantity of sulphuric acid which is liberated acts detrimentally by increasing the back electromotive force from the tanks, and by making the deposited zinc spongy, thereby making the zinc difficult to melt. To overcome these difficulties, they proceed thus: The electrolytic decomposition tanks are fitted with inlet and outlet pipes, the inlet pipes entering at the bottoms of the tanks and the outlet pipes being fitted to the tops of the tanks.

As there is a continuous deposition of zinc, and consequently a continuous liberation of free sulphuric acid, going on so long as the current of electricity is maintained, they provide for the removal of the free sulphuric acid by keeping up a continuous supply of fresh solution—neutral or nearly so—from the mechanical stirrers and passing this neutral or nearly neutral solution into the bottom of the electrolytic decomposition tanks; and as the molecules of solution which have been deprived of their zinc, and consequently have become more highly charged with free sulphuric acid, are lighter than those molecules which have not been deprived of their zinc, they rise to the top of the tank; and as the heavy neutral or nearly neutral solution is passed into the bottoms of the tanks, the lighter solution containing the largest quantity of free sulphuric acid is run off at the tops of the tanks, and so back to the stirrers, to be mixed with the ore, and so be neutralized, or nearly so, by the free sulphuric acid combining with the zinc oxide contained in the calcined ore forming sulphate of zinc.

The neutral, or nearly neutral, solution coming from the stirrers to replace the solution which has become highly charged with free sulphuric acid, as before mentioned, will, of course, dissolve more or less copper, iron, and silver each time it is passed over or mixed with the ore. Therefore it must, when necessary, be passed through the same cycle of operations to eliminate these impurities as before described. The apparatus for accomplishing this is conveniently arranged, when possible, so that the solution will flow from one set of tanks or apparatus to the next set by gravitation, or it may be pumped, siphoned, or forced from one set of tanks or apparatus to the next set.

The calcined ore, which has now been freed, or practically freed, from its zinc, copper, and part of its iron and silver, is thrown upon a filter or slope, so that the solution held in the mass of ore may drain out, and when the greater quantity of this solution is drained out, the mass of ore may be washed with water, producing a weak solution of sulphate of zinc, which weak solution may be evaporated to the necessary strength by a suitably arranged evaporating apparatus, made so as to

utilize the waste heat from the calcining or other furnaces. The residue of the ore, containing lead, silver, and gold, from the above operations is dried and smelted for lead, which lead carries all the remaining silver and the gold with it. This argentiferous and auriferous lead may be either treated electrolytically or by the Pattinson or other well known process for the separation of the silver and gold from the lead.

When calcining the ore for the purpose of oxidizing the metals and producing sulphuric acid, the resulting fumes are cooled and introduced, with a sufficient quantity of steam, into a fume-condensing chamber of suitable dimensions and constructed of suitable materials to resist the action of sulphuric acid, such fume-condensing chamber being fitted with suitable combs or plates of platinum or other suitable metal (and connected by properly insulated wires to an electrical machine), arranged with a space between each pair of plates or combs, so that there may be free access of the mixture of steam and fume to all points or surfaces of the plates or combs, such plates or combs to be properly insulated by electrical non-conductors. Upon a current of electricity being discharged from one set of plates or combs to the other set, ozone, ozonized air, or ozonized oxygen is formed, such ozone, ozonized air, or ozonized oxygen acting as a powerful oxidizing agent, which, in the presence of moisture, oxidizes the sulphurous anhydride or the sulphurous acid gas into sulphuric acid, and, owing to the temperature of the fume-condensing chamber not being sufficiently high to vaporize such sulphuric acid, it is condensed, and may be collected for concentration, distillation, or for any purpose for which sulphuric acid is used. In the process of precipitating by zinc the copper and silver from the liquors obtained from washing the ore by the use of mechanical stirrers they obtain a mass of copper in a metallic or semi-metallic state, mixed with more or less silver in a more or less spongy state. This mass is to be washed, preferably through a suitable sieve with water, for the purpose of removing any particles of metallic zinc to which it may be adhering. The mixture of finely divided copper and silver is then either filtered off from the supernatant liquid or allowed to settle, and the supernatant liquor decanted. It is then dried, melted, and cast into suitable form and size to be used as positive plates or anodes in an improved electrolytic process for the separation of the copper from the silver.

In carrying this into effect, they prepare an improved electrolytic decomposition tank of suitable dimensions, having a porous compartment or porous cell, that is, parts of the tank are separated from the other parts by a material of a sufficient degree of porosity, such, for instance, as biscuit ware, asbestos, thin wood, or the like. This porous cell or compartment they provide with an outlet pipe at or near the bottom, suitably arranged so that the level of the liquor with which the porous cell is to be filled may be under control. This may be obtained by bending the outlet pipe up outside the tank, and then having a piece of pipe of smaller diameter to slide inside the larger outlet pipe to act as an adjustable overflow, taking proper precautions to prevent the leakage of the liquor at the point at which the small pipe enters the large one. By this means—that is, by raising or lowering the small pipe—the level of the liquor in the porous cell will be under control. They then proceed to fill the porous cell and the outer cell of the electrolytic decomposition tank with a solution of cupreous chloride in hydrochloric acid, or a solution of cupreous chloride in sodium chloride, or a solution of cupreous chloride in sodium chloride and hydrochloric acid. They then arrange the outlet pipe from the porous cell so that the level of the liquor in the porous cell shall be about one inch lower than the level of the liquor in the outer cell of the tank.

To the outer cell there is to be fitted a supply pipe from a reservoir tank, through which pipe a constant supply of liquor is maintained in the outer cell, thence through the porous partition to the inside of the porous cell. They then hang in the porous cell a plate or other convenient form of argentiferous or auriferous, or argentiferous and auriferous, copper to be treated, to act as an anode, and in the outer cell they hang a thin sheet of copper to act as a cathode. They now connect the anode to the positive pole of a dynamo-electric machine or other suitable source of electricity, and they connect the cathode to the negative pole of the same source of electricity, and pass a current from the anode through the solution and porous partition to the cathode. This will have the effect of causing a deposit of metallic copper at the cathode, and cause the solution of a proportionate quantity of the metal or metals at the anode, and it will be found that not only the copper, but also the silver of the anode, will go into solution, as there is a constant flow of liquor, which has been to a greater or less degree deprived of its copper, in the outer cell to the inside of the porous cell, there to be charged with the metal of the anode.

The solution which has been charged in the porous cell with the metal of the anode is to be run through the outlet pipe of the porous cell, thence through the small sliding pipe inclosed in it, into tanks to be thus further treated. When a sufficient quantity of this solution has been collected, a sample is to be taken and the quantity of silver accurately estimated, and from the result of such estimation calculation is to be made to determine the quantity of iodide of potassium or other precipitant of silver to be added to the solution, to precipitate the whole of the silver contained in the total quantity of solution under treatment. The precipitate is allowed to settle, and the supernatant liquor is returned to the reservoir tank to be again run into the outer cell of the electrolytic decomposition tank, there to be deprived of part of its copper, and thence to the inside of the porous cell to be recharged with copper and silver, which silver is to be precipitated as before described. The object of this is to insure a continuous recovery of the silver and copper from the anodes, thereby reducing the capital locked up in the stock. It has also the object of reducing the cost of depositing the copper, as they deposit from a solution of a cupreous salt, and can by the use of such solution deposit just twice the quantity of copper by a given current that can be deposited from a solution of a cupric salt; and by the use of such a solution that is a solvent for the silver in the anode as well as the copper, they obviate the necessity of the frequent stoppage of the plant necessary under the old plan of working, with a solution of cupric sulphate to collect the residues containing the precious metal.

THE WIMSHURST ELECTRICAL MACHINE.

By THE INVENTOR.

YOUR readers will doubtless be glad to have the particulars of the working details for the more modern, or many-plated, form of the machine, similar in con-

Fig. 1.

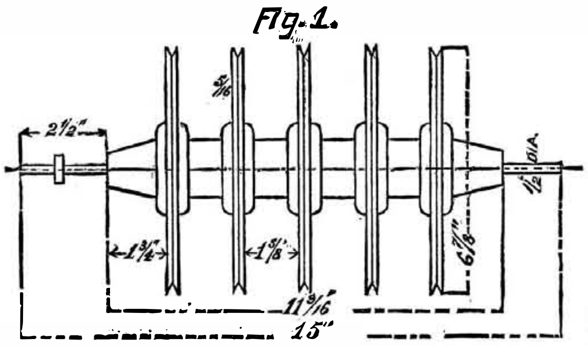


Fig. 2.

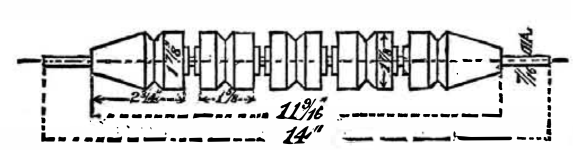
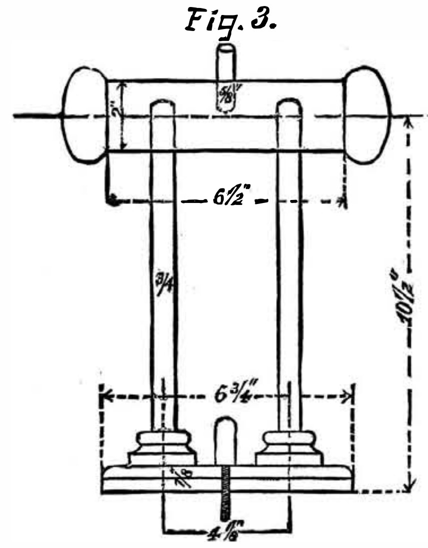


Fig. 3.



struction but not so large as the powerful instrument recently used by Prof. George Forbes in his lectures at the Society of Arts.

The leading characteristics of the new machines are that they have many plates, and that they are inclosed within a glass case, which to a great extent obviates the difficulties which the presence of dust offers to the student of statical electricity.

The following is a description of the working details of, perhaps, the simplest form of a machine with eight plates; a greater number of plates or a less number of plates may, of course, be used. But then the number of parts of each kind must be proportionally increased or decreased.

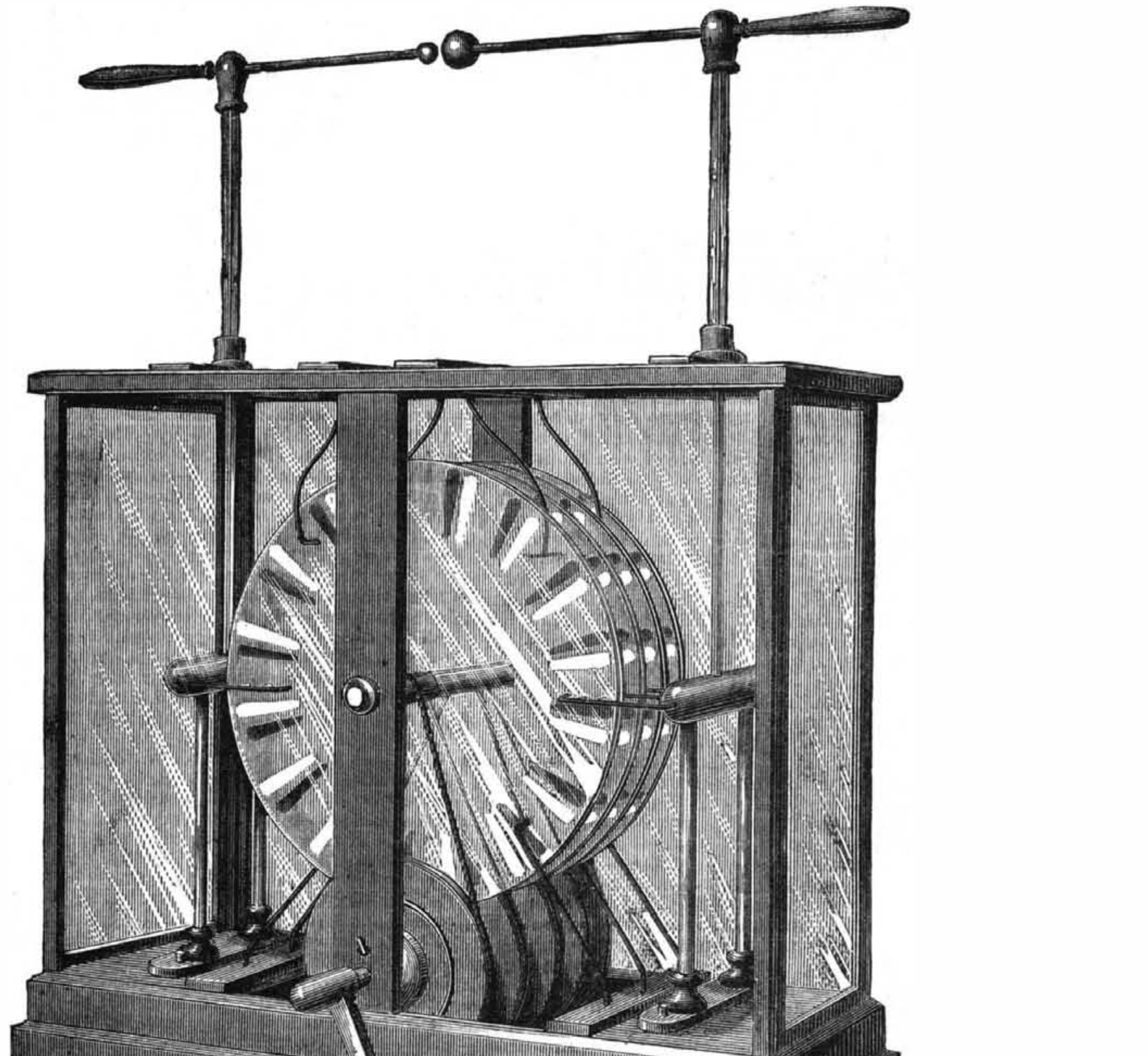
The case, so far as external appearance and finish are concerned, may be left to the taste, the ability, or the pocket of the maker. But the form shown in the drawing below will probably give the greatest satisfaction. The dimensions given are measured *inside* the case, viz., 24½ in. length, 11⅝ in. breadth, 18½ in. height, top of base to the frame at top.

The fitting together of the various parts of the case must be left to the skill of each constructor. But care should be taken that the corners of the base, or bottom of the case, are strongly put together, so as to prevent any twisting when the machine is lifted.

The stanchions have narrow grooves cut into them, and are so arranged that each plate of the glass which forms the sides of the case is slipped into its place from the top. The grooves for the end glasses are so cut that those glasses can be lifted up at any time and taken away to enable any necessary adjustments to be made inside the case.

The driving-wheels and spindle are represented in Fig. 1. To make these procure a piece of straight bar iron or steel, of soft quality, 15 in. long by ½ in. in diameter, drill centers in its ends, then true up one end for 1½ in. in length, and on this end cut a screw-thread. On this thread screw tightly a stout washer in order to form a collar against which the driving handle can be seated. The next thing to do is to fit on to the spindle a length of wood. Place the spindle with its wooden cover in the lathe, and true up the wood, making it 11$\frac{3}{16}$ in. in length by 1½ in. in diameter. Drill holes near each end through both the wood and the iron, and into these holes fit metal pins. This wooden portion of the spindle forms the base upon which the wheels are to be fitted and glued at the distances shown in Fig. 1. These wheels must be turned up with V grooves in their edges, and the sides slightly ornamented. After this, true up the uncovered portions of the iron spindle, so that it may run smoothly in the bearings, which are pieces of brass tube fixed into the stanchions of the case. The height for the center of this spindle is 4¼ in. measured up from the bench.

The spindle and the bosses for the glasses are represented in Fig. 2. For this spindle select a piece of bright steel wire 14 in. long by $\frac{7}{16}$ in. of an inch diameter, and a corresponding length of brass tube to fit the wire. Cut the tube into lengths slightly longer than those shown in the sketch, and on these lengths fit pieces of well seasoned yellow pine. Turn these up to form the bosses, taking care that the projecting piece which supports the glass will just fit the holes in the center of the glasses. Lastly, turn up the ends of the brass tube, leaving a sufficient length on each to project slightly beyond the vulcanized fiber washer with which the glasses are held upon the bosses. The length of the projecting ends of the brass tubes regulates the distances between the plates, and care should be taken to see that no other part than the ends of the tubes touch each other when the glasses are revolving. The total lengths of the five tubes must just fill up the space between the stanchions of the case. The height



THE WIMSHURST ELECTRICAL MACHINE.

for this spindle is 12¾ in., measured up from the bench.

The prime conductors are represented in Fig. 3, and are made of brass tube 6½ in. long by 2 in. diameter, the inside of which is filled with yellow pine. The ends are of mahogany, and are turned up to a hemispherical shape. The conductors are each supported by two glass rods, which fit into holes cut through the bottom of the brass tube and through the wood. The lower ends of the glass rods are firmly cemented into suitable stands, which can be removed from the case. The stand of each prime conductor is held in place by a steady pin at each end and by a screw in the center. It is advisable to fit a piece of vulcanite or wood over the head of these screws, as it will prevent its being a source of leakage for the electricity, and it will also make it easy to release and take away the prime conductor whenever it is required.

The carriers for the brushes are made of brass wire

Fig. 4.

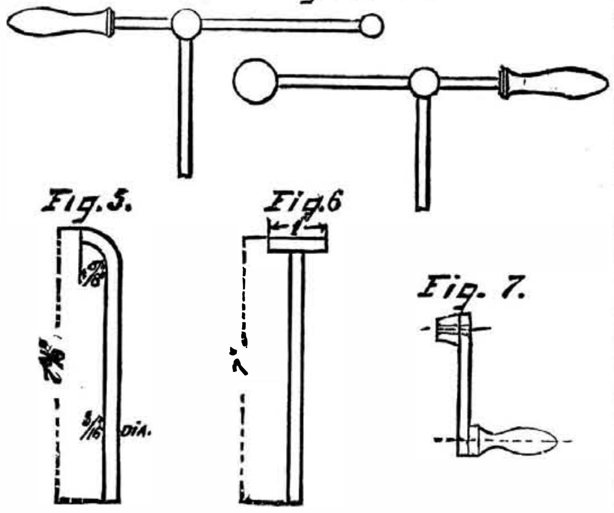


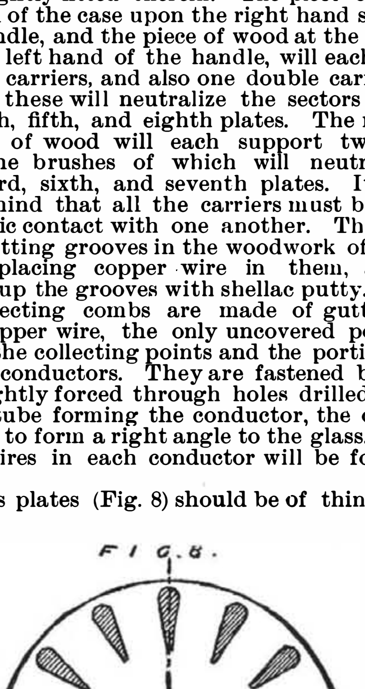
Fig. 5. Fig. 6. Fig. 7.

3/16 in. in diameter, and of a form shown in Figs. 5 and 6. Four of them simply have the ends bent to a right angle, and at the extremities small holes are drilled, into which the brushes are fixed. The remaining brush carriers are T-shaped, made up of pieces of straight wire, one end of each being filed hollow, and into this hollow a short length of small tube is soldered at a right angle to the wire. These tubes take a brush at each end. The new machine having eight plates, and, therefore, requiring sixteen brushes, four of these brushes will be held by the four carriers with the bent ends. They may, therefore, be called single carriers, while the remaining six carriers each hold two brushes, one brush being held by each end of the small tube. They may therefore be called double carriers. The single carriers consequently together hold four brushes, while the double carriers together hold twelve brushes, thus making up the sixteen. To support the carriers, four pieces of wood are fitted, two being at the top and two at the bottom of the case. These pieces should be so fitted that they can be removed at any time. Holes must be drilled in them at positions suitable for the brush carriers, and the ends of the carriers must be tightly fitted therein. The piece of wood at the bottom of the case upon the right hand side of the driving handle, and the piece of wood at the top of the case to the left hand of the handle, will each support two single carriers, and also one double carrier. The brushes in these will neutralize the sectors upon the first, fourth, fifth, and eighth plates. The remaining two pieces of wood will each support two double carriers, the brushes of which will neutralize the second, third, sixth, and seventh plates. It must be borne in mind that all the carriers must be brought into metallic contact with one another. This is best done by cutting grooves in the woodwork of the case, etc., and placing copper wire in them, afterward cementing up the grooves with shellac putty.

The collecting combs are made of gutta-percha-covered copper wire, the only uncovered portions of which are the collecting points and the portion within the prime conductors. They are fastened by having one end tightly forced through holes drilled through the brass tube forming the conductor, the other end being bent to form a right angle to the glass. Sixteen of these wires in each conductor will be found sufficient.

The glass plates (Fig. 8) should be of thin, flat, and

FIG. 8.



proper quality glass, 15 in. in diameter. The hole in the center should be 1¼ in. in diameter. The glasses must be well coated on each side with pale shellac varnish. The sectors should be of tinfoil, 2½ in. in length by nearly 1 in. broad at the outer end, and ⅛ in. broad at the inner end. They should be situated not more than ¼ in. from the circumference of the plate. Fourteen sectors on each plate will give about the best results.

To attach the glasses to the bosses, the best plan is to first test that the glass runs true when only lying upon the boss, then cement the vulcanized fiber washer to the free surface of the glass, then firmly screw the washer to the wood boss. But when using this arrangement, always be careful to see if one side of the glass is a little more concave or hollow than the other, and to see that the hollow side of the glass makes the surface upon which the washer is to be cemented: otherwise the plates will gape at the edges. Practice shows that the closer the glasses can be brought together, the better is the result.

The handle drawn in Fig. 7 may be of any form, but the one shown answers very well, screwing it on to the spindle. The thread being cut in its boss is, perhaps, the best method of attachment. This plan, moreover, insures the machine being always driven in the proper direction, as the handle will unscrew if turned the wrong way.

The driving belts are best made of the round leather used for sewing machines. The joint is made by scarfing the ends and stitching them together. The first, the third, and the fifth bands run straight, while the second and the fourth bands run crossed.

The terminals or discharging rods (Fig. 4) are simply straight wires ¼ in. in diameter. On one end of each is a vulcanite handle, and on the other end a brass ball. The balls should differ in size, and be highly polished; the ball on the right hand terminal should be nearly 2 in. in diameter, and the ball on the left hand rather less than ½ in. in diameter. The electricity is brought from the prime conductor to the terminal by a stout wire incased all its length in a thick glass tube which extends from the conductor to the terminal. Care must be paid to see that there is metallic contact between the wire and the conductor and between the wire and the horizontal terminal. The joint between the vertical glass tube and the terminal may be made by a wooden ball thickly polished, or by any more tasteful device.

Always remember that all glass used must be tested for insulation before labor is added to it. Frequently glass is of such a character as to be useless. Avoid all sharp edges and all points. One point wrongly exposed, or even a rough surface, will be fatal to good results.—*English Mechanic.*

A TOY ELECTRIC RAILWAY.

THE accompanying engraving represents a toy electric railway which has been on exhibition for several months in the electrical section of the Exposition of Industrial Arts and Sciences at Paris.

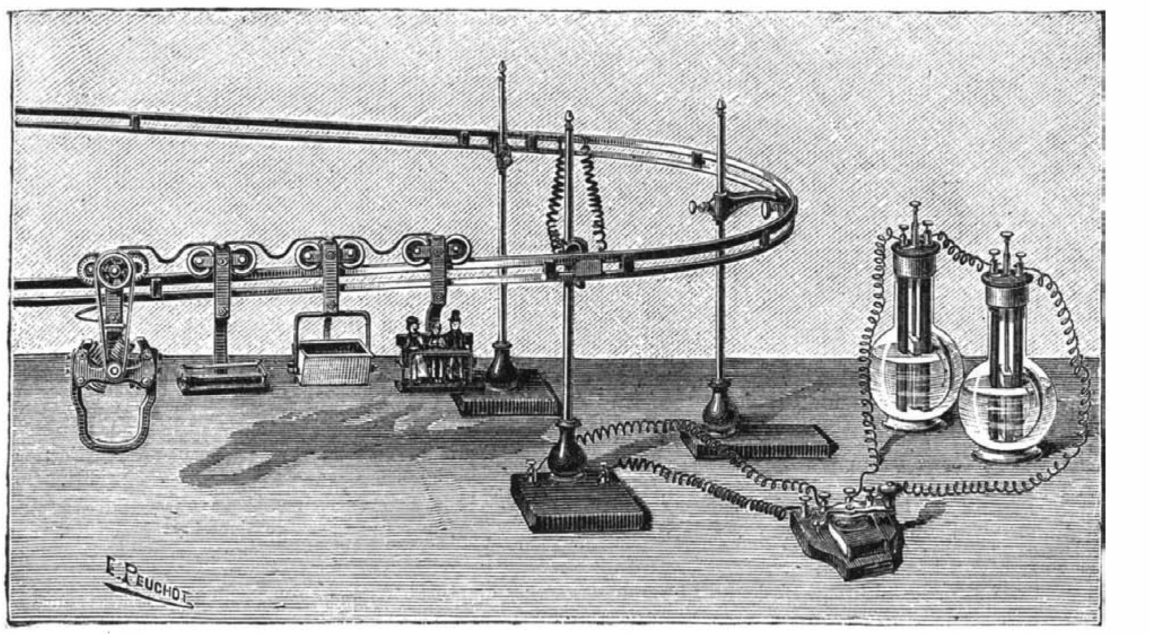
Mr. Brillie, its deviser, took his idea from the late Mr. Fleeming Jenkins' system of telpherage and Mr. Lartigue's single-rail railway.

The affair consists of a movable track formed of two strips of brass kept parallel at a certain distance from each other by insulating pieces, and supported by a certain number of standards that permit of giving the track any curve or grade.

The locomotive is a magneto-electric motor, without dead point, coupled to a certain number of cars of various forms, showing the different applications of the system.

A commutator is interposed in the circuit formed by the two rails, the motor, and the two fourteen-ounce bichromate batteries that suffice to actuate the system. This commutator is capable of taking three positions that correspond to the running forward at high speed, stoppage, and running backward at high speed. Intermediate notches permit, through the introduction of proper resistances into the circuit, of graduating the speed at will.

The whole affair, which is inclosed in a box, constitutes an interesting toy that is equally well adapted for the amusement of the young or to small cabinets of physical apparatus for elementary instruction.—*La Nature.*



A TOY ELECTRIC RAILWAY.

FERRIC CHLORIDE AS AN EXCITING AGENT.

By H. N. WARREN, R.A.

BASED upon the reducing action that zinc exerts over an acidified solution of potassium bichromate is the construction of the well known bichromate battery. And on a somewhat similar theory of reduction I have lately found an acidified solution of ferric chloride mixed with bromine to answer the purpose still more energetically, and at the same time assuming a constant action, a point which has long been desired with respect to the bichromate battery, the construction of the battery itself being almost identical with the bichromate bottle form, but charged with a concentrated solution of ferric chloride with a layer of bromine at the bottom, the solution being slightly acidified. Thus ferric chloride being far more soluble in water than potassium bichromate in the first instance, a much stronger solution may be obtained; the bromine so acting as to continuously convert the ferrous chloride, formed by the reduction of the zinc, back to ferric chloride, and in thus doing maintaining a constant action. With respect to the power of the electrical current produced, I have found it to be the most powerful yet examined, two small half-pint cells decomposing water most energetically, and three similar cells heated to intense whiteness two inches of fine platinum wire; while four large size cells, charged with the same solution, gave an intense arc between two graphite points, and very perceptibly volatilized platinum. All the more oxidizable metals, as well as silver and gold, were dissipated with great brilliancy when introduced between the points. The strength of the battery is slightly impaired after three hours' action, owing to the reducing action of the zinc somewhat overcoming the oxidizing effects of the bromine, but on allowing the battery to stand a short time, it fully recovers its original power. The bromine being once consumed may be again liberated by the introduction of a small quantity of bleaching powder, thus rendering the battery in every respect more constant, more powerful, and at the same time less costly in its construction than any other form of voltaic battery.—*Chem. News.*

SALICIN.

THE sudden increase in the makers' price of salicin from 7s. to 15s. per lb., which we announced recently, was followed later by a further advance to 40s. per lb., a price which was quoted on "'change." But it would be rash to say whether business has been done at this figure. The advance appears to be entirely artificial. One house has, as it is stated, secured the entire crop of willow bark of the coming season, and proposing to reap advantage therefrom, is forcing up the price of its active principle. A long price for salicin is by no means a new thing. Twelve years ago, previous to which it had been used as a mild tonic, as a substitute for quinine, Dr. T. J. Maclagan introduced it as a specific for acute rheumatism, and the price to retailers then was steady at 12s. per lb. As soon as Dr. Maclagan gave publicity to his excellent results in treating acute rheumatism by salicin a demand sprang up with which, for a time, makers could scarcely cope. The price advanced to 2s. 6d. per oz., and within a few months the very high figure of 10s. and 12s. per oz. was reached. As soon, however, as an abundant supply of willow bark was forthcoming and manufacturers had erected the necessary plant to meet the increased demand, the price began to decrease, until it had reached the rather abnormal figure at which it could be bought before the present rise. Apart from the greater facilities of production, another factor which affects the price of salicin is the more extensive use of salicylates. These are much quicker and more certain in action than salicin, and, although their use is contra-indicated when the heart is affected, and they give rise in many cases to annoying secondary symptoms, they have almost entirely taken the place of salicin in the treatment of acute rheumatism. The initiatory high price of salicin helped greatly to establish the salicylates. The former drug is generally administered in very large doses frequently repeated, as much as 30 grains being given every hour. This at any price above 4s. per oz. to the retailer is necessarily prohibitive to its general use, so that manufacturers by forcing up the price would lose on the one hand what they gain on the other.

The supply of willow bark is limited, but is practically sufficient for all requirements. Though obtainable from more than twenty species of Salix, there are only a few which yield it in sufficiently large quantity for manufacturers' purposes. *Salix alba*, *Salix caprea*, and *Salix purpurea* are the principal species operated upon, while certain kinds of poplar bark also yield sufficient salicin to be worth working. The bark is obtained principally from Germany and America. Although it grows abundantly in this country, most of the bark which has been tried, even of species which generally yield salicin, has been found useless. For example, the bark of several trees of *Salix purpurea* which grew near a chemical factory was tried, but it yielded nothing. The process of manufacture is very simple. The bark is placed in large cylindrical iron tanks into which steam is passed. This condensing, forms a concentrated infusion, which is drawn off and treated with lime to remove tannin and coloring matter. The clear liquor is then passed to the crystallizing vats, the crystalline deposit afterward collected, placed in a calico bag, and subjected to hydraulic pressure, whereby residual coloring matter is pressed out. The semi-dried matter is afterward recrystallized. Some time ago an attempt was made to utilize the spent bark for paper making, the fiber being tough and of considerable length. But whether the exper-

iment proved successful or not has not transpired. The proposal was not due to the low price of salicin, but to the unmanageableness of the waste bark, which manufacturers have either to burn or cart away at considerable expense. Although salicin was introduced into the last Pharmacopœia, the use of the remedy has not been increased thereby, and the present advance in the price has not the remotest connection with any growing demand for the drug.—*Chemist and Druggist.*

GASES FROM NEW WOOLEN GOODS.

A SEEMINGLY trivial observation led to a curious and instructive investigation in England recently. Paper in which woolen goods had been wrapped was observed to be spotted as if with common ink. Most of the spots had a perfectly definite outline, Round some, however, a faint brownish tinge appeared. A number of the spots were cut out and macerated in water for comparison with an equal weight of unstained paper which was similarly treated. The black spots gave a much more distinct acid reaction than the unstained portions, and the reaction was found to be due to sulphuric acid. This at first led to the supposition that the black spots might be due to free sulphuric acid, and which had been accidentally spurted upon the paper, and which on drying had charred it. Experiments were made with sulphuric acid, and of different strengths, put in a similar manner on the same paper and heated; but the black spots thus formed were very different in character from those in question. They had a much more strongly acid reaction with litmus paper, besides being different in appearance and in their behavior toward other reagents.

On treating some of the spots in question with nitric acid the black color disappeared, giving place to a green color, and on adding ammonia a deep blue was at once developed. Some of the spots were cut out and an equal quantity of unstained paper taken for comparison. Both were burned to ash, which was then dissolved and tested. Copper was found in the stained parts, while none was contained in the unstained.

The question now arose: How did the particles of copper oxide which originally existed in the paper get there? How did that usually greenish oxide become converted into a black compound?

It was evident that at first the paper had been free from black spots, but when woolen goods were wrapped in it, the spots gradually developed. On putting some test paper containing lead acetate among the woolen materials, it soon became brownish colored, and ultimately black, showing that sulphureted hydrogen was being liberated from the goods. It seems clear then that the objectionable smell which new woolen goods possess is due, in some degree, if not entirely, to the evolution from them of sulphureted hydrogen or of volatile organic sulphides.

Possibly the use of sulphurous acid in the bleaching process tends to the formation of some sulphur compounds, which slowly decompose, yielding sulphureted hydrogen, or one or more somewhat similar substances.

The particles of copper oxide evidently came from the oxidation of some brass buttons which had been carelessly left on some of the rags, introduced into the rag machine during the manufacture of the paper pulp, as it was only a comparatively small portion of the paper which was thus affected. The pale greenish particles of copper oxide were not readily seen at first, but when the sulphureted hydrogen from the woolen goods came in contact with the copper oxide, it formed the black sulphide of copper, and so brought into existence the mysterious black spots. Part of the sulphureted hydrogen thus arrested was evidently converted into sulphuric acid, which gave the acid reaction to litmus paper.

Mr. Wm. Thomson, from whose remarks before the Society of Chemical Industry we take the above, said in reply to a question that the small quantity of oxide of copper produced by the oxidation of a few brass buttons during the process of manufacturing the paper would have passed unobserved if woolen goods had not been wrapped in the paper. Then, sulphureted hydrogen came in contact with the oxide, converting it into black sulphide of copper, and so developing the spots.

SOLIDIFIED OILS.

By C. R. ALDER WRIGHT, D.Sc., F.R.S.

Solidified Oils produced by True Oxidation.—The power of combining with oxygen at the ordinary temperature, or at temperatures not excessively elevated above it, is not by any means possessed by all natural oils; in the absence of mucilaginous or albuminous impurities, which promote the development of "rancidity" (often accompanied by absorption of oxygen to a small extent), certain oils may be freely exposed to the air for moderately lengthened periods, and at all temperatures short of those at which decomposition by heat alone would be incipient, without absorbing such an amount of oxygen as to cause any material change in their composition or properties. Such oils are usually termed *non-drying* oils, of which olive, almond, and earthnut oils may be taken as representative kinds. Other oils, such as cottonseed oil, under similar conditions, gradually inspissate, and in thin films solidify more or less completely after some time, but do not alter thus sufficiently rapidly to be capable of use for the various purposes for which the true *drying* oils (such as linseed, hempseed, and poppyseed oils) are extensively used. A marked difference in chemical constitution is noticeable between the drying and non-drying oils as a class; the latter are essentially the glycerides of organic acids belonging to the acetic acid family (*i. e.*, expressed by the formula $C_nH_{2n}O_2$), in some instances admixed with the glycerides of oleic acid, belonging to the family next thereto in hydrogen richness (*i. e.*, indicated by the formula $C_nH_{2n-2}O_2$); while the former mainly consist of the glycerides of acids belonging to the still less hydrogenized family represented by the formula $C_nH_{2n-4}O_2$.* It is to this difference in relative proportion between carbon and hydrogen that the power of assimilating oxygen is probably ascribable, the "unsaturated" nature of the acids present in the drying oils enabling them to oxidize spontaneously, in a way impossible for acids of the "saturated" type.

This tendency to take up oxygen, however, appears to increase, *cæteris paribus*, with the amount of oxidation already effected, at least up to a certain point; that is, a drying oil in which the oxidation process has been already started will usually oxidize, or "dry," more rapidly than the same oil in a virgin condition. In consequence, the well known process of "boiling" linseed oil is largely employed, in order to facilitate its oxidation and solidification when used for the preparation of paint, varnish, and such like purposes. In some cases, simply heating the oil in a caldron suffices to enhance its drying qualities to the requisite degree, the small amount of contact with air thus brought about while hot affording a sufficient amount of oxidation to give the desired impetus to the further assimilation of oxygen during after-use.*

Ordinarily, however, the boiling is carried on with access of large bulks of air blown through the heated mass, or in presence of "driers," *i. e.*, substances found by experience to have the power of promoting the subsequent drying of the oil. Some of these, such as sulphate of zinc, appear to be incapable of directly communicating oxygen themselves; while others, such as the oxides of manganese and lead, may be regarded as directly furnishing a supply of that element by acting as "carriers" of atmospheric oxygen, and also as inspissating agents, after the manner of the metallic salts above alluded to. The final result in any case is to furnish a slightly oxidized product, more viscid than the original oil, and capable of "drying" more rapidly on exposure to air, *i. e.*, of more speedily combining with additional oxygen. For the manufacture of solid "oxidized oil" from linseed oil thus subjected to the preparatory boiling process, it suffices to expose a thin film of the oil freely to the air, and when this film has become moderately indurated to apply another over it, and so on until a varnish-like mass of some thickness results. For the production of materials of this description for the manufacture of linoleum and analogous products, the films are generally obtained by allowing the oil to flow from a reservoir above over the surface of a sheet of thin canvas or cotton scrim, or analogous supporting body, suspended vertically in a chamber copiously supplied with air, and capable of being warmed artificially if required, and of being freely ventilated. A number of parallel sheets being arranged side by side, the oil is allowed to flow down them in succession from a trough running on wheels overhead, somewhat after the fashion of a platform crane; and after the surfaces are thus moistened with fresh oil, air is freely admitted, the alternate "flooding" and aerial oxidation being repeated for some weeks, until the "skin" formed is of sufficient thickness. During the process a considerable amount of acrid vapor is generated, the glycerine of the oil being acted on by a subsidiary reaction, giving rise to the production of acrolein. Although loss of weight from this evolution of vapor is occasioned, yet a total gain in weight of several per cents. usually results, the quantity of oxygen fixed far outweighing the loss of matter by volatilization. If the oxidation has been properly carried out, the resulting product is a highly elastic solid, of notably higher specific gravity than the original oil, and insoluble in most of the ordinary oil solvents, such as ether and carbon disulphide. The following analyses by Cloez illustrate the nature of the change in composition thus produced by prolonged exposure to air:

LINSEED OIL.

	Before Exposure.	After Oxidation. Percentage Composition.	After Oxidation. Per 100 of Original Oil.
Carbon.........	77·57	67·54	72·27
Hydrogen......	11·33	9·88	10·57
Oxygen........	11·10	25·58	24·16
	100·00	100·00	107·00

POPPYSEED OIL.

	Before Exposure.	After Oxidation. Percentage Composition.	After Oxidation. Per 100 of Original Oil.
Carbon.	77·50	66·65	71·38
Hydrogen......	11·40	9·93	10·64
Oxygen........	11·10	23·42	25·08
	100 00	100·00	107·10

While the original oils correspond approximately with the composition

$$\left.\begin{matrix} C_3H_5 \\ (C_{18}H_{31}O)_3 \end{matrix}\right\} O_3$$

representing the triglyceride of an acid of formula $C_{18}H_{32}O_2$† (requiring carbon 77·90, hydrogen 11·16, oxygen 10·94), the oxidized products have obviously lost from one-fourteenth to one-twelfth of the carbon, and about one-fifteenth of the hydrogen originally present, while the oxygen is more than doubled. It is usually stated in text-books, on the authority of Mulder, that linseed oil completely oxidized in this way has lost the whole of the glycerine originally present; even if this were so, the carbon thus removed would not represent more than one-nineteenth of that originally present, so that obviously carbonic acid or other volatile carbonaceous compounds must be produced at the expense of the carbon of the fatty acid present. But recent observations of A. H. Allen have shown that linseed skins are still capable of yielding by saponification a considerable fraction of the amount of glycerine given by the raw oil, while but little diminution in glycerine-forming power is brought about during the preliminary "boiling" process; so that the composition of "solidified" linseed oil is probably a somewhat complex one, doubtless subject to variation with the conditions obtaining during its production, but being essentially that of a mixture of bodies, some formed by simple absorption of oxygen, thus producing the glycerides of more oxidized acids than those originally present (in a polymerized condition ?), and some formed by the breaking up under oxidizing influences of these products, either during the act of formation or subsequently. Before passing from the subject of oxidized oils of this class, it may be noticed that various oils not strictly of the drying class, but rather intermediate between these and the non-drying oils—*e. g.*, cottonseed oil and rape oil—become increased in specific gravity and viscidity by being subjected to the action of a current of air blown through them in a heated condition; sufficient warmth is generated by oxidation, when the process is once started, to maintain the requisite temperature without the application of any additional heat. These "blown" oils are often spoken of as "oxidized" oils; they generally mix readily with mineral oils, and are used as lubricants and for various other purposes, including the adulteration of castor oil, which is distinguished from most other vegetable oils in a natural condition by its high specific gravity.

Solidified Oils prepared by Sulphuration.—The oils most readily yielding solid sulphurized masses by heating in contact with free sulphur are, ordinarily, those that oxidize most readily, *i. e.*, they belong to the class of drying oils, of which linseed and hempseed oils may be taken as typical. When linseed oil, somewhat warmed, and flowers of sulphur are stirred together, the latter dissolves, but without entering into chemical combination until the temperature is considerably raised. At 130° C. to 140° C., several per cents. of sulphur are thus soluble without immediately setting up chemical action, slowly separating again as free sulphur on cooling and standing; but at temperatures of 150° and upward, addition of sulphur to the oil causes a more or less vigorous evolution of sulphureted hydrogen and other volatile products; the fluid thickens, and ultimately becomes converted into an elastic solid mass, somewhat resembling caoutchouc. A variety of patents based on this reaction have been from time to time taken out during the last twenty years or so, the object being, in most cases, to prepare an elastic solid mass, capable of use along with other materials as a substitute for vulcanized rubber or as an ingredient to mix therewith for cheapening purposes. As an illustration of these processes, the following one may be quoted, patented by Austin Goodyear Day (No. 1010, April 15, 1871). He prepares "an elastic compound resembling caoutchouc, and designed chiefly for mixing with caoutchouc," by heating together about 14 lb. of cottonseed oil, 8 lb. of asphaltum, and 8 lb. of coal tar; when hot, 14 lb. of linseed oil are added, and then 10 lb. of sulphur are gradually stirred in, when the temperature is about 270° F. (132° C.); finally, the temperature is raised to 310° F. to 330° F. (155° C. to 165° C.), to complete the action. It is preferred also to add ½ lb. of camphor. Oils sulphureted by processes akin to this in general characters, constituting "vulcanized" oils of various kinds, have, of late years, been used to some considerable extent as ingredients in compositions intended for covering electrical conducting wires so as to insulate them; and when mixed with paper pulp and analogous materials, for the formation of articles made of so-called "vulcanized fiber." For substances of these natures, it is eminently probable that an increased demand will hereafter be set up, as the application of such compositions to various miscellaneous purposes becomes more and more extended. Products of this description, and various articles made therefrom, were exhibited at the International Inventions Exhibition, and attracted considerable attention.—*Industries.*

* Castor oil belongs to an entirely different group of glycerides, the formula representing the family of the chief acid therein present being $C_nH_{2n-2}O_3$.

* The experiments of Hubl on boiled and unboiled linseed oil indicate that the latter is capable of combining with iodine to a larger extent than the former, the difference in amount of iodine taken up being several per cents. of that capable of combination with the unboiled oil; while the power of combination with iodine is due to the same cause as enables union with oxygen to take place, viz., the "unsaturated" nature of the acids present as glycerides.

† Linoleic acid, the acid of which most drying oils mainly consist in the form of glyceride, is usually regarded as indicated by the formula $C_{16}H_{28}O_2$; but recent observations on the amount of alkali requisite to produce complete saponification tend to show that the molecular weight is really somewhat higher, the formula $C_{18}H_{32}O_2$ being more nearly in accordance with the numbers thus obtained, as well as with the data yielded by combustion analysis.

THE VELOCITY OF LIGHT IN AIR AND REFRACTING MEDIA.*

PROF. MICHELSON, after a brief statement of some of the difficulties under which experimenters in this branch of science labored, gave a history of the measurements of light from the time of Galileo.† Before his time it was supposed that the perception of objects was instantaneous. As soon as the idea was promulgated that light proceeded from a body to the eye, the question arose, "How long does it take?" Galileo than began his experiments. The only absurdity was that it was supposed that the velocity of light and sound might be of the same order of magnitude. Galileo suggested that two men should be stationed as great a distance apart as two lights should be visible. Each should have a lantern with a slide. As soon as the second experimenter saw the light uncovered by the first, he should uncover his lantern. The interval which elapsed from the uncovering of the first light till the observer perceived the light of the second would be the time required for the light to come and go, plus the time required for the second observer to perceive the light and make the required movement. This experiment was tried by the Florentine Academy, and resulted in the conclusion that the time required was insensible. Yet upon this rude experiment was based the principle which underlies one of the most celebrated methods used in recent times for the attainment of the same object.

The subject was next approached from the astronomical side. In 1676 Roemer, in a communication to the French Academy, claimed that from his observations of the eclipses of the first satellite of Jupiter, he found that light required time to pass through the celestial spaces. He found eleven minutes to be the time required for light to pass over a distance equal to the radius of the earth's orbit. Dominique Cassini contested the right of Roemer's hypothesis to reception as an established theory, on the ground that the observed inequality might be a real one in the motion of the satellite itself. Other observations showed that the time assigned by Roemer for the "light equation" was somewhat too great. In 1809 it was fixed by Delambre at 493·2 seconds. In 1875 Glasenapp, then of Pulkowa, showed that results between 496 and 501 seconds could be obtained.

Bradley observed another peculiarity, known as the aberration of fixed stars. He was attempting to find the parallax of a number of stars, and his observations led him to see that this was not the true parallax, but some other phenomenon. The theory of aberration is not quite satisfactory. The constant of aberration, however, gives a relation between the velocity of light and the velocity of the earth in its orbit, from which, by a simple calculation, the time required for light to pass from the sun to the earth may be deduced.

Professor Michelson then referred to the expense

* Synopsis of a lecture by Prof. Albert A. Michelson, delivered before the Civil Engineers' Club of Cleveland, Sept. 14, 1886.

† Taken chiefly from Prof. Newcomb's book.

incurred by various nations in their observations of the transit of Venus. Astronomers now agree that the determination of the velocity of light gives a more accurate result than anything they can hope to gain from observations of the Venus transit. The distance of the earth from the sun is the astronomical base line, or astronomical unit. The distance from the sun was supposed to be 95,000,000 of miles, and as it required 500 seconds for light to traverse this distance, it was concluded that it moved 190,000 miles per second. Physicists were hopeless of measuring such a velocity by any means at their command, so no serious attempt was made between the time of the futile effort of the Florentine Academy and that of the researches of Wheatstone, Arago, Fizeau, and Foucault, nearly two centuries later.

In 1840 Fizeau presented a paper on this subject to the Academy of Sciences. His method was founded on the first experiment proposed by Galileo. A telescope was fixed upon a house at Suresne, pointing to the Hill Montmartre. A second telescope, looking directly into the first, was placed upon this hill, the distance between being about 8,633 meters. A small reflector was fixed in the focus of the second telescope. A transparent glass, fixed in the eyepiece at an angle of 45 degrees, caused a beam of light to be sent from the first to the second telescope. This was directly reflected back, and, on its return, could be seen as a star by an eye looking through the first. A revolving wheel, with 720 teeth upon its circumference, was fixed upon the eyepiece of the latter, so that the beam of light both in going and coming had to pass between the teeth.

In 1838 Arago proposed a method based upon that of the revolving mirror of Sir Charles Wheatstone. He took pains to demonstrate that it was possible, by the use of a revolving mirror, to decide between the theory of emission and that of undulations by determining the relative velocities in air and in a refracting medium. The difficulties, however, were such that he never succeeded in carrying out his experiments. Foucault and Fizeau, about the beginning of 1850, showed that the motion of light was slower through water than through air. There are two theories of light, the undulatory and the corpuscular, and this fact that light travels more slowly through water establishes the falsity of the corpuscular theory.

The next measures were those of Cornu. He adopted Fizeau's invention of the toothed wheel. His result was far superior in point of accuracy to that of Foucault, who gave for the velocity of light 298,000 kilometers per second. Michelson, the next experimenter, gave a result of 299,910 kilometers per second. Messrs. James Young and George Forbes, experimenting in Scotland, promulgated a theory that there was a difference in the velocities of different colored rays, but it is probable that the phenomena observed by them arose from some other cause than a difference in the velocities of red and blue rays.

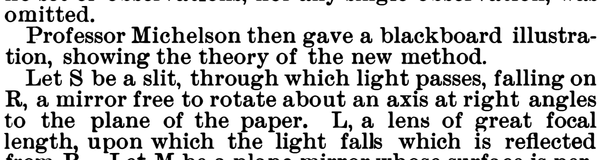
In Cornu's memoir upon the determination of the velocity of light, several objections are made to the plan followed by Foucault. The most important among these was that the deflection was too small to be measured with the required degree of accuracy. To employ this method, therefore, it was necessary that the deflection should be increased. In November, 1877, a modification of Foucault's arrangement suggested itself to Professor Michelson, by which this result could be accomplished.

The first experiment tried with the revolving mirror produced a deflection considerably greater than that obtained by Foucault. So far the only apparatus used was such as could be adapted from the apparatus in the Naval Academy. At the expense of $10 a revolving mirror was made which could execute 128 turns per second. This was installed at the laboratory in May, 1878. The distance used was 500 feet, and the deflection was about twenty times that obtained by Foucault. Various observations, with some changes in the apparatus, were made up to June 5, 1879, when the first of the final series of observations was made. Thirty sets made previous to this were rejected. After this time no set of observations, nor any single observation, was omitted.

Professor Michelson then gave a blackboard illustration, showing the theory of the new method.

Let S be a slit, through which light passes, falling on R, a mirror free to rotate about an axis at right angles to the plane of the paper. L, a lens of great focal length, upon which the light falls which is reflected from R. Let M be a plane mirror whose surface is perpendicular to the line R M, passing through the centers of R, L, and M respectively. If L be so placed that an image of S is formed on the surface of M, then, this image acting as the object, its image will be formed at S, and will coincide point for point with S. If now R be turned about the axis, so long as the light falls upon the lens, an image of the slit will still be formed on the surface of the mirror, though on a different part; and as long as the returning light falls on the lens an image of this image will be formed at S, notwithstanding the change of position of the first image at M. This result, namely, the production of a stationary image of an image in motion, is absolutely necessary in this method of experiment. It was first accomplished by Foucault, and in a manner differing apparently but little from the foregoing.

Suppose that R is in the principal focus of the lens, L; then, if the plane mirror, M, have the same diame-



ter as the lens, the first or moving image will remain upon M as long as the axis of the pencil of light remains on the lens, and this will be the case, no matter what the distance may be.

When the rotation of the mirror, R, becomes sufficiently rapid, then the flashes of light which produce the second or stationary image become blended, so that the image appears to be continuous. But now it no longer coincides with the slit, but is deflected in the direction of rotation, and through twice the angular distance described by the mirror, during the time required for light to travel twice the distance between the mirrors. This displacement is measured by the tangent of the arc it subtends. To make this as large as possible, the distance between the mirrors, the radius, and the speed of rotation should be made as great as possible.

The second condition conflicts with the first, for the radius is the difference between the focal length for parallel rays and that for rays at the distance of the fixed mirror. The greater the distance, therefore, the smaller will be the radius. There are two ways of solving the difficulty: First, by using a lens of great focal length; and, secondly, by placing the revolving mirror within the principal focus of the lens. Both means were employed. The focal length of the lens was 150 feet, and the mirror was placed about 15 feet within the principal focus. A limit is soon reached, however, for the quantity of light received diminishes very rapidly as the revolving mirror approaches the lens.

The revolving mirror consisted of a cast iron frame resting on three leveling screws, one of which was connected by cords to the table, so that the mirror could be inclined forward or backward while making the observations.

A point of interest was the measurement of the speed of rotation. A tuning fork, bearing on one prong a steel mirror, was used. This was kept in vibration by a current of electricity from five "gravity" cells. The fork was so placed that the light from the revolving mirror was reflected to a piece of plane glass, in front of the lens of the eyepiece of the micrometer, inclined at an angle of 45°, and thence to the eye. When fork and revolving mirror are both at rest, an image of the revolving mirror is seen. When the fork vibrates, this image is drawn out into a band of light.

When the mirror commences to revolve, this band breaks up into a number of moving images of the mirror, and when, finally, the mirror makes as many turns as the fork makes vibrations, these images are reduced to one which is stationary. This is also the case when the number of turns is a submultiple. When it is a multiple or simple ratio, the only difference is that there are more images. Hence, to make the mirror execute a certain number of turns, it is simply necessary to pull the cord attached to the valve to the right or left till the images of the revolving mirror come to rest.

The electric fork had about 128 vibrations per second. No dependence was placed upon this rate, however, but at each set of observations it is compared with a standard Ut_3 fork, the temperature being noted at the same time. In making the comparison, the sound beats produced by the forks were counted for sixty seconds. It is interesting to note that the electric fork, as long as it remained untouched and at the same temperature, did not change its rate more than one or two hundredths vibrations per second.

Professor Michelson then gave a description of some of the mechanical appliances used in making his experiments. With regard to the revolving mirror, two binding screws, terminating in hardened steel conical sockets, held the revolving part. This consisted of a steel axle, the pivot being conical and hardened. The axle expanded into a ring which held the mirror. This was about one and a quarter inches in diameter and two-tenths of an inch thick. It was silvered on one side only, the reflection taking place from the outer or front surface. A species of turbine wheel was held on the axle by friction. This wheel had six openings for the escape of air. The air entering on one side acquires a rotary motion, and carries the wheel with it.

Other mechanical appliances were explained by blackboard diagrams.

In answer to the question, "Were your results at Annapolis different from those obtained here?" Professor Michelson stated that the results at Annapolis gave for the velocity of light 186,360 miles per second, while the result in Cleveland was 186,325.

Mr. Eiseman: What were Professor Newcomb's results?

Professor Michelson: Professor Newcomb made a number of experiments, using the same method as Foucault's. When he finished his first series of experiments, he found that his result was 200 miles less than mine. He tried to discover the error first in his own work, and then in mine. He asked me to repeat my experiments, which I did. His best result is now given as 186,330 miles per second.

A Member: How did these results compare with the best results obtained by observation of Jupiter's satellites?

Prof. Michelson: I think the result obtained by Fizeau coincided remarkably with the result obtained from observations of the eclipses of Jupiter's satellites. That was 190,000 per second.

Fizeau	190,000	miles per second.	
Foucault	185,000	"	1862
Cornu	186,660	"	1874
Michelson	186,360	"	1879
"	186,325	"	1882
Newcomb	186,330	"	1882
Young and Forbes	187,250	"	1881

As it had been announced that Messrs. Forbes and Young had detected a difference of two per cent. in the rates of transmission of red and blue light, Professor Newcomb, in his experiments at Fort Myer, watched carefully for traces of color in the reflected image, but nothing could be discovered.

GASTRIC DIGESTION IN THE HORSE.

By H. GOLDSCHMIDT.

AFTER a period of inanition varying from 12 to 36 hours, 18 horses were fed on a diet of known composition (oats, straw, bread, bran); at periods varying from 1½ to 17½ hours afterward, they were killed, and the contents of their stomachs immediately examined. The contents of the portions of the stomach which differ in structure were separately investigated, the points noted being reaction, nature of acid, quantity of acid, of dextrose, and of peptone and dissolved proteid. Artificial digestion experiments were performed on fibrine, white of egg, and starch, with extracts of the mucous membrane of the various parts. The results obtained were as follows:

1. That the stay of food in the horse's stomach is much longer than has been hitherto supposed. Various experiments are detailed, the object of which was to trace the course the food takes during the peristalsis of the stomach.

2. That the contents of the horse's stomach are relatively very dry; the reason of a few exceptions to this rule is unknown.

3. The course of gastric digestion is divisible into four periods: (a) Amylolysis alone takes place; lactic acid is formed; duration one hour. (b) Both amylolysis and proteolysis occur, the latter especially in the region of the fundus, where alone glands which contain oxyntic cells are found; lactic acid and a small amount of hydrochloric acid are present; duration about six hours. (c) Stage of local digestion. Amylolytic digestion only occurs in the œsophageal sac, the region of the lesser curvature, and the greater part of the pyloric antrum. This is accompanied by the formation of lactic acid. Proteolytic digestion alone occurs in the region of the fundus, and is accompanied by the formation of hydrochloric acid. This stage lasts as a rule until the next meal; but if this interval is long, a fourth stage (d) may occur in which only proteolysis occurs.—*Zeit. Physiol. Chem.; Jour. Chem. Soc.*

HEALTH AND LONGEVITY.

By Dr. J. R. BUCHANAN.

LIFE is an influx from the world of invisible power, aided by various forms of influx from the material world, without which it would promptly cease. If this naked statement should seem fanciful or erroneous to any reader, he may be just to himself by suspending his opinions until he shall have received the demonstration. We have all been educated into false opinions on this subject, and it is almost as difficult for the American scholar to release himself from the influence of education and habit in such matters, as for the Arab to release his mind from the influence of the Koran.

It has been only within the last ten years, and as the sequel of investigations of the seat of life beginning in 1835, that I succeeded in ascertaining the absolute falsity of the doctrines on this subject maintained by all scientific biologists at the present time, and demonstrating that the human body is only a tenement, of which life is the builder, and which drops into decay when life deserts it to meet its more congenial home in a nobler realm.

It is not therefore in the physical, but in the spiritual constitution that the real basis of his character, his health, and longevity is to be found, for the primitive germ or protoplasm of man cannot be distinguished from that of a quadruped or bird. It is the invisible and incalculable life element that contains the potentiality or possibility of existence as a quadruped or a man, as a virtuous or vicious, and as a long lived or a short lived being The life element of the germ limits the destiny of the being. That life element is invisible.

This truth, however, does not contradict the truth of development and the capacity of science to estimate the probable health or longevity of an individual from his organization, for the life force organizes a body in accordance with its own character. And the development of the entire person shows the character of the vital force as modified by the environment of food, air, motives, and education. The brain, no less than the body, indeed, more fully than the body, shows the elements of the life and the tendency to health and longevity, or the reverse, upon which an expert cranioscopist can give an opinion.

In accordance with the doctrine of influx, and in accordance with the functions of the brain, we are compelled to recognize health and longevity as more closely associated with the higher than the lower faculties, the moral rather than the animal nature. This is the reason that woman, with a feebler body but a stronger moral nature, ranks higher in health and longevity than man. And although from four to sixteen per cent. more males are born, women are generally in predominance, often from two to six per cent. The researches of the Bureau of Statistics of Vienna show that about one-third more women than men reach an advanced age. De Verga asserts that of sudden deaths there are about 100 women to 780 men. The inevitable inference is that the cultivation of virtue or religion is the surest road to longevity, and the indulgence in vice and crime the most certain ruin to the body and soul.

There is a curious illustration of these principles in the evidence of life insurance companies in reference to spirit drinking and abstinence. The two oldest life insurance companies of England, the General Provident and the United Kingdom, have made records for forty-five years which distinguish the total abstainers and the moderate drinkers. Drunkards they do not insure at all. The care with which lives are selected for insurance results in a smaller rate of mortality among the insured than in the entire population. This gain was but slight among those classed as moderate drinkers, for their mortality was only three per cent. less than the average mortality. But among the total abstainers it was thirty-one per cent. less. Thus the proportion of deaths among moderate drinkers compared to that of total abstainers is as 97 to 69.

The temperance advocate would assume that this was owing entirely to the deleterious effects of alcohol, and that is partially true. But there is a deeper reason in the difference of the two classes of men. The man in whom the appetites are well controlled by the higher energies of his nature, and who has therefore no inclination to gluttony or drunkenness, has a better organization for health and longevity than he in whom the appetites have greater relative power, and who seeks the stimulus of alcohol to relieve his nervous depression. The inability or unwillingness to live without stimulation is a mark of weakness, which is an impairment of health. And this weakness predisposes to excessive and irregular indulgence, though it may not go so far as intoxication.

The effects of marriage furnish a parallel illustration. It is well known that bachelors are more short lived than married men, but this is not owing *entirely* to the hygienic influence of marriage. It is partly owing to the inferiority of bachelors as a class. The men who remain celibate are either too inferior personally to win the regard of women, or are generally deficient in the strong affections which seek a conjugal life and the energies which make them fearless of its responsibilities and burdens. Evidently they have not as a class the robust energies of the marrying men and the urgent motives to compel them to regular industry and

prudence. Everything which stimulates men to exercise the nobler qualities of their nature is promotive of health and longevity. And the *true* religion which anthropology commends will increase human longevity in proportion as it prevails.

In future numbers the true basis and indications of longevity in man will be fully illustrated.

The attainable limits of human longevity are generally underrated by the medical profession and by popular opinion. Instead of the scriptural limit of threescore and ten, I would estimate twice that amount, or 140 years, as the ideal age of healthy longevity, when mankind shall have been bred and trained with the same wise energy that has been expended on horses and cattle. Of the present scrub race, a very large number ought never to have been born, and ought not to be allowed to transmit their physical and moral deficiencies to posterity.

The estimate of 140 years as a practical longevity for a nobler generation is sustained by the number of that age (fourteen, if I recollect rightly) found in Italy by a census under one of the later Roman emperors. But for the race now on the globe a more applicable estimate is that of the European scientist, that the normal longevity of an animal is five times its period of growth, a rule which gives the camel forty years, the horse twenty-five, the lion twenty, the dog ten, the rabbit five. By this calculation, man's twenty years of growth indicate 100. But growth is not limited to twenty, and if we extend the period of maturing to twenty-eight, the same rule would give us 140 as an age for the best specimens of humanity, which has been attained in rare cases, its general possibility in improved conditions being thus demonstrated.

There are many fine examples of longevity at this time. The famous French chemist Chevreul has just completed his hundredth year at Paris, in the full vigor of his intellect.

The *Novosti*, a Russian journal, recently mentioned the death in the almshouse of St. Petersburg of a man aged 122 years, whose mental faculties were preserved up to his death, and who had excellent health to the age of 118.

We have similar examples in the United States. Mrs. Celia Monroe, a colored woman, who died a few weeks ago at Kansas City, was believed to be 125. She was going about a few days before her death.

Farmer O'Leary of Elkton, Minnesota, is over 112. Noah Raby of Plainfield, New Jersey, is in his 115th year. He supports himself by his work in the summer, and looks like a man of 80.

Of very recent deaths we have: Amos Hunt of Barnesville, Georgia, who died at 105, leaving twenty-three of his twenty-eight children. Mrs. Raymond of Wilton, Connecticut, was still living recently in her 106th year. Ben Evans, part Indian, part negro, a great hunter of Wilkes County, Georgia, died at 107, baptized after he was 100. Mrs. Betsy L. Moody died on the 4th of July in Cape Elizabeth, Maine, aged 104. Wm. Henry Williams of Cincinnati died a few months ago at 102. James Fitzgerald of Prince Edwards Island, over a 100 years old, is still able to work. Mrs. Lydia Van Ranst lately died on East 16th Street, New York, aged 100 years and 10 months; and Mrs. Johanna O'Sullivan in Boston in her 103d year. Mrs. Betsy Perkins of Rome, New York, was apparently in excellent health when she died suddenly at the breakfast table in her 101st year. Rev. Hugh Call died in Wayne County, Indiana, at 104. After his hundredth year he once fancied death was near, and sent for his family to see him die. But when they arrived in midwinter, they found the old man busy cutting wood to make a fire for his visitors.

Many of these examples show that the faculties of both soul and body ought to be maintained in good condition to the last, as fruit falls from the trees ripe and perfect. When we leave our earthly tenement, we ought to leave it in a respectable condition, and not carry any infirmities from it to the better world.—*Journal of Man.*

DANGERS OF WATER GAS.

DISPATCHES from Troy, N. Y., bearing date of Jan. 17, were well calculated to attract widespread attention, but the notoriety secured was gained at a most painful expense. Three persons were destroyed when seemingly engaged in ordinary conversation, while over a score of others were more or less severely prostrated, and the cause of all this suffering was instantly traced, once the wheels of investigation were put in motion, to an accidental inhalation of the fuel water gas distributed from the works of the Troy Fuel Gas Company. Briefly stated, the leading facts appear to be the following:

About 7 P. M., on Sunday, January 16, a young woman (Rose Stone) employed as a domestic in a restaurant owned by C. C. Howe—it is located in the Crowley building, on south side of River Street, and quite close to the manufacturing plant of the fuel gas works—was seized with a seemingly inexplicable fit of illness. Bewildered and apparently unable to make known her condition to those close by, she rushed into the open air, gaining egress to the rear yard through an open doorway, and fell to the ground in a fainting condition. Jno. Talmage, a son-in-law of the restaurant keeper, startled by the strange conduct of the girl Stone, followed closely in her wake, and at once instituted measures for her revival. A young daughter of Talmage was now taken sick, and the father, who speedily succeeded in his attempts at restoring the first victim to consciousness, while performing similar offices over his daughter, succumbed. The restaurant keeper (Howe) who was in another portion of the house, was found by Mrs. Talmage—she seems to have been the one who suffered least—in a dazed condition; and he exclaimed to her, "I guess I am going to die." To make an end of the preliminary statement, eleven persons in the Howe domicile were more or less prostrated, and all complained of similar symptoms—headache, nausea, and drowsiness. A physician (Dr Martin) was summoned, and he rather astonished the inmates of the plague-stricken spot—temperature of the outer air was extremely frigid—by at once throwing open all the windows and doors. Turning his attention to the sufferers, Dr. Martin explained to them that they had inhaled gas, which they stoutly denied. No gas was used on the premises, and none of the odors characteristic of gas had been perceived by them. However, the doctor on previous occasions had been called upon to relieve similar cases, and he asserted that the street pipes of the fuel gas company must have been fractured. That being the case, the escaping gas—the top crust of the earth being frozen stiff—followed through the lower strata and entered the cellar of the restaurant, subsequently finding its way to the upper apartments of the building. The gas—it is a simple uncarbureted fuel gas, manufactured under the Lowe process—being odorless, performed its work unperceived by the sense of smell. The houses Nos. 395 and 397 River Street were next examined. The first, a saloon, was found to be untenanted—Dr. Martin arrived on the scene at 9 P. M., and the outside investigation was commenced, say, at 10 P. M.—but a startling state of affairs was brought to light at No. 397. The front door was locked, but the investigators entered a side alley, ascended a narrow flight of steps that led to a covered porch and landing, and stood before a door opening into the second floor. This was locked, but repeated knocks failing to elicit a response, the barrier was broken down and an entrance effected. In the kitchen was seen the form of an elderly woman, apparently asleep in an arm chair. A set of false teeth was clenched in one hand, but there were no evidences of a life and death struggle. However, the woman was dead. Hurrying on to the front apartment, the dead body of a second female, lying on the floor with a blanket wrapped around her, and a tin slop bucket placed near her head—she had evidently tried to vomit but could not—was discovered. In the same room, sitting upright on a lounge, with fingers locked and his hands resting on his knees, was found the dead body of a male person. The corpse was dressed in ordinary clothing, with the exception that the feet were shoeless. The victims were subsequently identified respectively as Mrs. Caroline Bennett; her daughter, Mrs. Wm. Gilfillan; and Charles Pratt, a visitor of the younger woman. At No. 397½ and several other houses on the line of River Street the inmates had suffered more or less severely; but fortunately knowing to what cause to attribute their illness, these adopted proper measures for relief.

At the instance of Dr. Martin, shortly after his arrival at the Howe restaurant, word of the break in the mains was sent to Supt. Geer at the fuel company's works, and the current was at once shut off. One of the most peculiar features of the case is the varying manner in which different physical systems were affected. Mr. Barnes, an electrician, was reduced to such an extremity that he was only saved by the presence of mind of his wife, who, to use Mrs. Barnes' words, "put the battery on him;" but Mrs. Barnes herself, subjected to precisely the same influences that prostrated her husband, and hovering over his very person, was affected but slightly—that is, when compared to the state to which he was reduced. It might be explained that Mr. Barnes and his wife reside at 399 River Street.

To recapitulate, it seems that not less than 20—in all probability 30 would be nearer the mark—persons were more or less affected by the gas, and that three victims answered with their lives. It is horrible to contemplate what the actual result would have been did it so happen that the gas failed to manifest itself, or rather to reach to the altitude gained by it at 7 o'clock, until, say, four hours later, or when those subjected to its insidious attack were wrapped in sleep. Troy would have been treated to a genuine holocaust, save that instead of the victims having been destroyed by fire, fuel gas would have been the responding destroyer. There can be no quibbling over the Troy disaster. The proper source is made plain through the result of the coroner's preliminary investigations, and in the subsequent admissions of Mr. Geer, of the Fuel Gas Company, as well. In fact, perhaps the results developed at the autopsy ordered at the coroner's request have never before been paralleled in this or any other country. Drs. Bouticon and Morris, while in the act of opening the bodies, were nearly overcome by inhaling the gases that escaped from the vitals of the subjects, and in fact the first named physician was so seriously affected that he had finally to retire from the operating room before the dissection was completed. It should be borne in mind that the occurrence of January 16 was not the initial warning that had been given to the people of the city in the matter of the noxiousness of the gas sent out from the offending establishment. Plenty of such warnings had been received, notably one that, if memory serves aright, occurred on January 5. On that date—luckily the affair happened shortly before noon—some 15 persons were more or less affected from inhaling gas that had entered their stores and houses in a manner precisely similar to the way recounted above. Again, on a day in last fall, many of the workers in the laundries—the operators of these establishments are extensive users of the fuel gas—were stricken down from the effects of the gas. But these latter instances attracted no particular attention, simply because no fatal results ensued. The latest disaster, however, provoked prompt action, and at a special meeting of the Council, held on January 18, the franchise granted the fuel company was suspended; but in justice to the managers of the company, it should be explained that they voluntarily suspended active operations prior to the Council's action. Judging from the present temper of the Troy authorities, it is quite likely that an exhaustive examination of this subject will be carried out to completion, and the final outcome will be awaited with interest.

While not desirous of influencing or anticipating the verdict which will ultimately be arrived at, we submit that the case as it stands looks bad for the fuel company. The superintendent, Mr. Wm. Geer, is reported by the Troy *Daily Times*, in its issue for January 17, to have said, in the course of other explanations volunteered by him in regard to the terrors of the previous day: "We used the old steam heating company's pipes"—the fuel company purchased the plant and franchises of the defunct Troy steam heating company—"in some places, and that caused the trouble. We have had no break in our cast iron pipes; they don't leak. All the trouble is with the wrought iron pipes. There is an odor to the gas, but it is so faint that it can scarcely be detected near a fixture where there is a leak. Our gas can be odorized by putting in naphtha or carbolic acid." If Mr. Geer is reported correctly, and there is no reason to doubt it, his employers will be called upon to shoulder a grave responsibility. They permitted the use of mains, notoriously defective, for conveying in large quantities and at heavy pressures an odorless (or practically so) gas which certainly carries in it not less than 40 per cent.—we are convinced, from the mode of manufacture pursued at Troy, that 50 per cent. would be nearer the truth—of the virulent poison, carbonic oxide. Further, the promoters (through Mr. Geer, who ought to know about it, if any one does) admit that a distinct odor could be imparted to the gas by treating it with either naphtha or carbolic acid; but as neither the one nor the other of these substances was employed, we can draw but one conclusion. That conclusion is, naturally, predicated on the fact that the cost of the impregnated article would be in excess of the "unadulterated" product, whose baneful potency will be vividly remembered in Troy for many a day. It is needless to say that cheap fuel gas is a desideratum; but we are not prepared to admit that its importance is of such pressing moment as to call for the vending of an article, even be the methods of its distribution approximately secure, that takes foremost rank in the list of poisons. In taking present leave of this disagreeable subject, we would remind our readers that, despite the immense quantities of fuel gas used in the regions where natural gas is obtainable, we have yet to hear of a single death from gas asphyxiation in those localities; and is not that immunity fairly attributable to the fact that analysis reveals an extremely low content of carbonic oxide in the gaseous product evolved from nature's laboratories?

[Since the above was written, the verdict of the coroner's jury has been received. It attributes the disaster to the negligence of the fuel gas company, and recommends that an exhaustive examination be made by the authorities.]—*Gas Light Journal.*

VOLCANIC ERUPTION OF SILVER.

ON THE OCCURRENCE OF SILVER IN VOLCANIC ASH FROM THE ERUPTION OF COTOPAXI OF JULY 22 AND 23, 1885.*

By J. W. MALLET, M.D., F.R.S., University of Virginia.

A FEW months ago I received from Senor Julian R. Santos, of Ecuador, formerly a pupil of mine in the laboratory of this university, a specimen of volcanic ash collected at his place of residence, Bahia de Caraguez, on the coast of the Pacific, about 120 miles nearly due west from Cotopaxi. This, the highest and among the most mighty of the active volcanoes of our globe, burst forth into eruption about 11:30 P. M. on July 22, 1885, and the ash began to fall at Bahia de Caraguez at 7 A. M. on the next day, the 23d. It fell there to the depth of several inches, this fact alone indicating the discharge of an enormous amount of solid matter into the atmosphere, although Senor Santos wrote to me that the unsettled condition of the country, disturbed by revolutionary movements, prevented his making extended inquiries, which might have ascertained the area covered by the fall of ashes.

The specimen sent me consisted of a very finely divided powder, mobile and soft to the touch, of light brownish gray color. Under the microscope it appeared to be made up of minute granules and spicules, in general with sharp, more or less splintery edges. These were for the most part colorless and transparent, or white and translucent; some were reddish, some dark bottle green, some brown, some black and opaque. Most of those clear enough to freely transmit light showed brilliant colors in a field of polarized light. Quartz, two feldspars (one white, and one pink or reddish), augite, magnetite (strongly attracted, and easily removed by the end of a magnetic needle), and thin scales of deep red specular iron oxide were easily distinguished.

The ash on being strongly heated before the blowpipe, or even in considerable quantity in a small platinum crucible over the blast lamp, turned dark red-brown, and fused to a nearly black slag.

On being boiled in its original state with water, it gave up 0·21 per cent. of soluble matter. The solution gave very distinctly the reactions of chlorine, a sulphate, and sodium; in a less marked degree the reactions of potassium. On boiling with strong hydrochloric acid, 6·94 per cent. was dissolved, in addition to that already extracted by water; the acid solution was deeply colored by iron.

The specific gravity of the ash was found = 2·624 at 18° C. as compared with water at the same temperature.

An analysis of the material taken as a whole, *i. e.*, without any previous mechanical separation of its constituent minerals, and without previous digestion with water or acid, but dried at 100° C., gave the following results:

SiO_2	56·89
TiO_2	trace
Al_2O_3	19·72
Fe_2O_3	4·06
FeO	3·65
MnO	trace
MgO	1·91
CaO	5·87
Na_2O	5·14
K_2O	1·96
Li_2O	trace
Ag	"
Cl	"
SO_4	"
PO_4	"
H_2O	0·62
	99·82

Silver was first noticed after fusing as usual with mixed sodium and potassium carbonates, and dissolving in excess of hydrochloric acid, on the addition of sulphureted hydrogen to the solution, which had been freed from silica; the sulphur thrown down by ferric chloride present was observed to be distinctly brown, and on being filtered out and carefully burned off before the blowpipe it left a minute bead of metallic silver. All the reagents and vessels used were scrupulously examined, but the silver could not be traced to any of them. It was afterward found that the metal could be obtained from the ash by furnace assay—fusion with pure lead carbonate, sodium carbonate, and a little cream of tartar, and cupellation of the lead button produced; and a comparative experiment was

* A paper read before the Royal Society, Jan. 6, 1887.

made, with negative result, using larger quantities of the same reagents, but omitting the volcanic ash.

It was ascertained that silver could be extracted from the ash by boiling it with a solution of ammonia, or of potassium cyanide, or of sodium thiosulphate, but the metal was not dissolved out in appreciable amount on boiling with nitric acid. Hence, as seems most probable, it was present in the ash as silver chloride. The fact of its being found in the solution in hydrochloric acid of the mass resulting from fusion with the alkaline carbonates is of course easily explained by the solvent action upon silver chloride of the chlorides of sodium and potassium, and (when such minute quantities are concerned) of hydrochloric acid itself.

The discovery of silver in the ash in question adds for the first time this metal to the list of elementary substances observed in the materials ejected from volcanoes, and the addition derived some special interest from the fact of the ash having come from the greatest of the volcanic vents of the great argentiferous chain of the Andes.

Lead, which was found by Senor Santos himself, when a student here in 1879, in a specimen of ash from the eruption of Cotopaxi of August 23, 1878,* was sought for in the ash now reported upon, but neither it nor any other heavy metal besides silver was detectable.

Several concordant experiments proved that the silver was present to the extent of about one part in 83,600 of the ash, or about two-fifths of a troy ounce per ton of 2,240 pounds. Small as is this proportion, it must represent a very large quantity of silver ejected during the eruption, in view of the vast masses of volcanic ash which must have been spread over such area as is indicated by the fall at so distant a point as Bahia de Caraguez.

* Chemical News, Oct. 17, 1879 (vol. xl., p. 186).

THE SUN'S HEAT.

SIR WILLIAM THOMSON lately delivered, at the Royal Institution, an interesting lecture on "The Probable Origin, the Total Amount, and the Possible Duration of the Sun's Heat." He began by pointing out that, during the period of the last 3,000 years, of which we have more or less authenticated historical records, the amount of heat received annually on this earth from the sun does not seem to have changed. Vegetable and animal life is to-day, to all appearances, the same as it was 3,000 years ago. This, however, does not prove that a gradual change is not taking place, for it is quite conceivable that a change may take place so slowly as to be inappreciable in the comparatively brief period during which accurate observations have been made. The lecturer then referred to the Helmholtz theory, and cautioned his hearers against carrying it too far, by the assertion that the sun can become hotter by shrinkage. This reasoning, when put in plain English, is about as follows: The sun, on account of getting cooler, must shrink, and because it shrinks it must get hotter. This is evidently a paradox, and, therefore, impossible in nature. The sun cannot get hotter, but it can nearly, if not quite, maintain for a comparatively long period its temperature by virtue of shrinkage. One kilogramme of water falling through a distance of 425 m. on our globe acquires energy which, at the moment of impact, is sufficient to warm the mass by 1° C. The same mass falling on the surface of the sun 15 m. only would acquire the same rise of temperature, since the acceleration on the sun is about 27½ times that on the surface of the earth. Thus we see that under the action of gravity on the sun, enormously more energy, and, consequently, enormously more heat, will be developed for every unit of mass as compared to the same process on our globe. According to the lecturer, the heat continually streaming out from the sun is mostly due to the mechanical process of gravitation. Sir William Thomson also asked his hearers to disabuse their minds of the idea that the amount of heat emanating from a square meter of the sun's surface is something inconceivably great or wonderful. The amount is quite within our powers of calculation, and in fact is only from fifteen to forty-five times the heat which is usually developed on a square meter of the fire grate area of a locomotive. In this way the problem is brought within the sphere of actual calculation, and the heat emanating from a square meter of the sun's surface represents an energy of 78,000 h. p. Now, imagine a deep pit of one square meter section, filled with some kind of mass, and let the walls of this pit be absolutely impervious to heat. Then, if it were possible to concentrate 78,000 h. p. into one shaft provided with blades which would stir up the mass, the mechanical energy thus transformed into heat would cause the top surface of one square meter to glow with the same intensity as a square meter of the sun's surface. Roughly speaking, it would for this purpose be necessary to concentrate the horse power of eight modern ironclads into one square meter of surface, and as this is, of course, mechanically impossible, we must try to find another way of representing this process. Now, imagine the material dug out of the pit to be lifted up and allowed to again descend into it on a perfectly frictionless screw. Then, if this mass is prevented from turning, the screw would have to turn, and this might agitate the mass, and so produce the rise in temperature. Now, imagine the whole of the sun's surface perforated by such pits one square meter at the surface, and tapering to a point at the center, and let the screws have a gradually diminishing pitch, to represent the compression of the mass, as we approach the center. Then it can be shown by calculation that, under the enormous force of gravity existing on the sun, the descent of the masses on their screws need only be 35 m. per annum in order to represent the continual expenditure of 78,000 h. p. each. Now, instead of supporting these masses on their screws, let the screws be taken away, and let the masses be supported by their own gaseous pressure. Then as the heat diminishes through radiation, the pressure will slightly diminish, and allow the mass to descend. Or, in other words, the whole surface of the sun will shrink at the rate of 35 m. per annum, and, in so doing, will perform sufficient mechanical work to keep up the present emission of heat. Now, this shrinkage represents a diminution of the radius of the sun of 1 per cent. in two thousand years, and, assuming that the difference of the reciprocals of the sun's radius is equal for equal amounts of heat given out, which is a very probable law, we find that it would require fifteen million years for the sun to shrink to a quarter of its original diameter. That is to say, the sun, fifteen million years ago, would probably have been four times its present size. After giving out twenty million times the present annual amount of heat, the sun would have the density of lead and half its present diameter. It is probable that materials cannot exist in the gaseous state when of such great density, and on these grounds the total amount of heat yet obtainable from the sun is probably less than twenty million times the present annual supply. It is sometimes suggested that the heat of the sun may, in a large measure, be due to chemical action. But a moment's reflection will show that this cannot be the case. The utmost energy which could be obtained from the most potent chemical combination is probably short of three thousand calories, which is equivalent to the energy developed by a body falling forty-five kilometers (twenty-eight miles) on the face of the sun. Now, when we compare the small height of twenty-eight miles with the thousands of miles which we know is the height of the protuberances and coronas and other effusions on the face of the sun, it will be seen that the energy of chemical action goes for nothing as compared to the enormous mechanical forces at work. From the foregoing calculations, the lecturer drew the conclusion that the sun may last and the earth may remain habitable for the present animal and plant life for another ten million years. Inquiring into the antecedents of the sun, he showed that the present planetary system could not have been produced by the collision of two masses and consequent scattering of planets round the center which forms the present sun; and that probably the planetary system is the result of the collision of particles of matter, or even atoms originally scattered through a very large space. If two bodies, each of half the sun's mass, situated on diametrically opposite points of the earth's orbit, were to be left to their own attraction, they would require about half a year to come into collision. The collision would last about an hour, and the energy thereby transformed into heat would suffice to produce a sun such as our sun might have been fifteen million years ago, but could not produce our planetary system. If one of the bodies had a transverse velocity of 68 m. per second (just about the velocity of a fast express engine), the impact would not be central, and the resulting system would have a period of rotation equal to that of our planetary system. If the mass of the present planetary system were scattered throughout space to such an extent that the density would be no greater than that of air in the best Sprengel vacuum, the mutual attraction of the atoms would cause them to conglomerate, and the process would only occupy a comparatively small number of years. Hence, it is quite possible that our planetary system, and in fact the whole cosmic system, is the result of the attraction between atoms and the heat developed by their impact.

[NATURE.]

THE ESKIMO.

SPECIAL interest attaches to a paper on "The East Greenlanders in their relations to the other Eskimo Tribes," contributed by Dr. H. Rink to the current number of the *Deutsche Geographische Blatter* (Bremen, 1886). Hitherto these hyperboreans have been studied by independent observers chiefly in Alaska at the eastern, and in Greenland and Labrador at the western, extremity of their domain, while through lack of sufficient materials the intermediate branches thinly scattered round the Arctic shores from the Mackenzie to Baffin Bay have been mostly neglected. Here, however, we have for the first time a comprehensive ethnological survey of the whole field by perhaps the greatest living authority on the subject, based on the rich collections recently brought to Europe by Capt. Holm from East Greenland, by the brothers Krause and A. Jakobsen from Alaska, and by F. Boas from the central region of Baffin Land.

With these materials before him, and keeping in view the facts already determined by previous students, Dr. Rink is able to throw much light, if not on the origin, at least on the general line of dispersion, and still more on the social evolution and art history of the Eskimo race. He makes it sufficiently evident that their primeval home must be placed in the extreme northwest, on the Alaskan shores of the Behring Sea, where they probably acquired a knowledge of some of the useful industries connected with navigation, fishing, and hunting from the neighboring Indian tribes of Athabascan stock. From this point the migratory movement appears to have been partly across the neck of the Alaskan Peninsula to the Copper River, where their further progress in this direction was arrested by the Thlinkit Indians on the coast and by the Athabascans in the interior. But their wanderings were chiefly directed toward the north and east, that is, along "the line of least resistance" around the unoccupied Arctic seaboard down to Baffin Bay, which seems to have formed a fresh point of dispersion, southward to Labrador, and eastward to East and West Greenland.

Dr. Rink is inclined to accept the view of Capt. Holm, that the Angmagsaliks, or East Greenlanders, found their way round the unexplored north coast of Greenland to their present homes, and that the West Greenlanders passed from Baffin Bay directly southward, while a mixed race, most probably including old Norse elements, was developed at the southern extremity of the peninsula. In the extreme west there has also been a slight intermingling, with Thlinkits about the Copper River, and Athabascans back of Kotzebue Sound; but elsewhere the Innuit and Karalik (Western and Eastern Eskimo) have kept entirely aloof, nowhere amalgamating with the Red Man, and keeping mainly to the seaboard throughout the whole extent of their domain, which, between the Copper River and Cape Farewell, Greenland, cannot be estimated at less than 7,000 miles in extent, although scarcely anywhere exceeding 150 miles inland from the coast. This explains the curious fact that the social organization of the Indian tribes in families, gentes, phratries, confederacies, and nations can nowhere be detected among the Eskimo, unless to it is to be attributed a certain restriction in the choice of a wife, and an obligation to lend each other mutual aid, universally recognized among all branches of the race. Even the general distribution into tribes, assumed by most writers, appears to be quite groundless, and the final syllable, *mut, miut*, of the so-called tribal names, meaning "dweller," "inhabitant of," shows that they are purely *topographical* terms without any ethnical significance whatsoever. Thus, Angmagsalingmiut, Mahlemiut, Aglemiut = inhabitants of the *Angmagsalik, Mahle, Agle* districts, and so on; so much so, that a family migrating from one of these districts to another changes its name accordingly. Hence Dr. Rink considers it sufficient for all practical purposes to class the whole race into the following seven *geographical* groups: 1, South Alaskan; 2, North Alaskan; 3, Mackenzie; 4, Central (Baffin Land, etc.); 6, Labrador; 6 and 7, West and East Greenland. Between these various groups there certainly exist differences, by which they may often be readily distinguished; but these are mainly of a social and linguistic, and to a less extent of a physical character; and such is the great uniformity even in the structure of the Eskimo tongue, that an East Greenlander and an Alaskan, if fortuitously thrown together, would soon begin to understand one another. It is noteworthy that in Greenland, where the language has been most carefully studied, greater differences are observed between the eastern and western than between the northern and southern dialects—a circumstance doubtless due to the different routes followed by the two streams of immigration from the central region. Compared with the West Greenland dialect, taken as written standard, the Labrador is found to contain 15, the Central 20, the Mackenzie 31, and the Alaskan 53 per cent. of different root words—relations which correspond remarkably well with the conclusions arrived at, on other grounds, regarding the general migratory movement from Alaska, the assumed cradle of the race.

But here an important exception is formed by the Aleutian Islanders, who are treated by Dr. Rink as a branch of the Eskimo family, but whose language diverges profoundly from, or rather shows no perceptible affinity at all to, the Eskimo. The old question respecting the ethnical affinities of the Aleutians is thus again raised, but not further discussed by our author. To say that they must be regarded as "ein abnormer Seitenzweig" merely avoids the difficulty, while perhaps obscuring or misstating the true relations altogether. For these islanders should possibly be regarded, not as "an abnormal offshoot," but as the original stock from which the Eskimos themselves have diverged. It is remarkable that in his new work on "Alaska and the Seal Islands," Henry W. Elliott discovers a striking resemblance between the Aleutians and the Japanese. They constantly remind him of "Japanese faces and forms in another costume," so much so that in his opinion they form a "a perfect link of gradation," not between the Eskimo and Red Man, nor between the Eskimo and Asiatic hyperboreans, but "between the Japanese and Eskimo" (p. 173). Mr. Elliott may have here unconsciously hit upon the solution of a very interesting ethnological problem, for in his "Classification of the Varieties of the Human Species" (*Journal* of the Anthropological Institute, May, 1885), Prof. Flower also connects the Eskimo with the Japanese: "Every special characteristic which distinguishes a Japanese from the average of mankind is seen in the Eskimo in an exaggerated degree, so that there can be no doubt about their being derived from the same stock. It has also been shown that these special characteristics gradually increase from west to east, and are seen in their greatest perfection in the inhabitants of Greenland, at all events in those where no crossings with the Danes have taken place."

The Aleutians would thus help to bridge over the somewhat abrupt gap still undoubtedly separating the Eskimo and Japanese groups. At the same time, this view suggests a primeval line of migration from Japan through the Kurile Islands and Kamchatka to the Aleutian chain and Alaska, which again presents other difficulties of a somewhat formidable character. In the first place, the Japanese appear to be themselves only comparatively recent intruders in Niphon, whose primitive inhabitants were the Ainos, a people of totally different physical type. Hence it is not easy to understand how they could have thrown off an easterly branch, which has had time to develop into the Eskimo, probably the most specialized of all existing races. In the second place, in his "Tales and Traditions of the Eskimo," Dr. Rink himself advances some solid reasons for bringing the Eskimo, not from Asia at all, or at least not in the first instance, but from the interior of the North American continent. He holds in fact, with some other ethnologists, that they were originally inlanders, who, under pressure from the American Indians, gradually advanced along the course of the Yukon, Mackenzie, and other great rivers to their present homes on the Behring Sea and Frozen Ocean. But a discussion of these contradictory theories, for which a solution may yet be found, must be deferred to another occasion. Meantime enough has probably been said to show the highly suggestive character of the paper under review.

A. H. KEANE.

VEGETABLE PRODUCTS OF EAST AFRICA.

SCARCELY a tribe in Eastern Africa but grows some kind of cereal, searches for some sort of edible tuber, or utilizes one or more varieties of wild fruit.

On Zanzibar Island, the red loamy soil produces durra (*mtama*), maize (*mahindi*), sweet cassava (*mhogo*), a species of pea growing on a tall bush (called *mbalzi*), cocoanut palms, bananas, mangoes, oranges, lemons, custard apples, and other fruits. The cocoanut palms are chiefly utilized for the preparation of palm wine (*tembo*). In Unyamwezi, the people cultivate rice, sorghum (*mtama*), small millet, sweet potatoes, yams, ground nuts, beans of all sorts, tomatoes, citrons, and bananas in abundance. The favorite beverage is millet beer (*pombé*).

At Konduchi, maize and millet grow well. Dar-es-Salaam has plantations of rice, cocoanut palms, maize, and sweet cassava. At present plantains and maize are the staple articles cultivated and consumed by the Wasambara. Excellent ginger grows wild, and is also cultivated by the natives for their own use. In Magila occur plots of bananas, sweet cassava, and rice. Tamarinds (*mkwaju*) and doum palms, or *mlala* (*Hyphæne thebaica*), grow wild.

The common vegetable products of Usambara are

rice, sweet cassava, maize, and sugar cane. Oil palm trees, or *mchikichi* (*Elæis guineensis*), are to be found at intervals. The cocoanut palm seems to cease with the first outlying range of mountains, or as soon as the sea breeze is shut off, but beyond that the banana becomes very abundant, and its unripe fruit, boiled and threaded on the twigs of bushes to dry in the sun, forms the staple food of the highlanders. Thus prepared the banana acquires a flavor very like that of the potato.

On the Rufigi, in times of scarcity, the people eat roots, and the heart of a kind of palmetto (locally called *milala*) which tastes much like the heart of the cocoanut palm. The Mawanda, besides fish, dig up a white tuber, about the size of a potato, in the forest. This they cut into thin slices, and soak in the river for a day, afterward thoroughly drying it in the sun, pounding and boiling, or making it into flour. The beer made from it is said to be very good and strong. The Marongwe people possess cocoanut palms, sugar cane, and bananas, and distill an ardent spirit in stills of native manufacture.

In the Shishongi country, Southern Mozambique, grows a cherry-like fruit, known to the natives under the name of *simwerbi*, furnishing a delicious and refreshing feast. Its juice is, however, so heavily laden with India rubber that the mustache gets varnished, and the lips almost cemented together, when the fruit is eaten. The berry is, nevertheless, one of the most palatable fruits of the country, with a lusciously sweet taste and milky juice. It has a few light brown enameled seeds, and grows in luxuriant abundance upon a large evergreen tree. Elephants appreciate this fruit quite as highly as men. The natives look upon the trees in the light of a granary during a couple of months or so, when they are golden with their crop. The fruit is at its best in the middle of January, and at that season it is made into a very pleasant wine, decidedly the best drink prepared by the natives, who also produce fermented beverages from the *imbongwa*, the *mayogomela*, the waterboom, the *umtshangowa*, and a species of palm, all wild and uncultivated bush growths.

The *imbongwa* is the rubber plant of the country. It bears an edible fruit, which yields the juice that is fermented into wine. The fruit is about the size of an orange, with a yellow skin or shell, easily broken by the thumb nail. It contains a number of flattish seeds, which are embedded in a small quantity of acid pulp, saturated with sweet juice. The seeds and pulp are squeezed out and watered, and then put in the sun to mature. The plant is a climber, with a light brown, rough, lumpy bark, and a stem occasionally as thick as a man's arm. The rubber furnished by it is of the kind known as "fingers."

The *makwaka*, a very highly prized Tonga food luxury, is prepared from the large calabash-like fruit of a deciduous shrub, greatly appreciated by elephants. The calabash is full of a bright orange colored seed, about as large as a shilling when ripe, and at that time covered with a thick glutinous coat. The seeds are dried upon a wickerwork frame, fixed over a hole, with a fire kindled at the bottom. The seeds acquire a flavor from the smoke, and assume a dark brown color.

The roasted seed coat or testa is then stripped off the seed by the women, pounded in wooden mortars, and pressed into drums made from *umtonto* bark. In that stage it is very like oat cake, and when mixed with honey is palatable, notwithstanding its pervading bitter taste. There is a refined way of preparing it green, when it is called *shugutsu*, and is deservedly in high estimation. In this form of preparation, the seeds are soaked in a succession of quantities of water, to extract their bitter flavor before they are stamped. In this state, however, the product is so rich and rare that it is not to be bought. A dark colored oil drops from the drums of matured *makwaka* in considerable quantity, and has proved to be a good lubricant.

That part of Southern Mozambique occupied by the Hlenga tribe produces a kind of vine called *umtshangowa*, whose flowers are most fragrant, while the edible fruit is made into blood red wine by the natives. In the Sabi River valley occurs a notable palm, the *umfuma* or *umkowan*, which grows to a height of one hundred feet, is thicker in the middle than above or below, and has a fruit somewhat like the cocoanut in appearance, but consisting of three large seeds in a husk, which are eaten after they have been made to sprout.

The cultivation between Dar-es-Salaam and the Kingani River embraces maize, cassava, millet, peas, mangoes, and bananas. Wild "cherry" trees (*kunazi*) occur. At Akeda Ferhan, sugar cane, millet, maize, cassava, peas, melons, pumpkins, saffron, castor oil plant, papaw, tamarinds, and cotton are cultivated, also tomatoes (*nyaya*). In the Shire country, when provisions are scarce, use is made of wild herbs, mushrooms, and *masuku*, the last named being a fruit resembling a pear, with russet rind, and three large grooved stones inside, which falls immediately it is ripe. A noticeable feature in Makualand is the very extensive cultivation of the cashew tree, from whose fruit is distilled a very strong spirit called *arripa*.

On the shores of Lake Nyassa, several wild fruits are eaten. One is a yellowish green ball, about as large as a Tangerine orange, with a raw tasting pulp like a medlar, and called *malembe*. Another is the *ntuza*, a green plum with several stones. It is uncommonly good, and would make a fine fruit if cultivated. It is sometimes dark purple, like damascenes. A tree bearing an edible fruit called *maula*, resembling a small rennet, with a sweetish taste, but a large stone in the middle, grows on the western and northern sides of the lake. Here they make *moa* beer, from a mixture of cassava and small millet. It seems to be inferior to *pombe*.

Cassava meal, eaten after grinding and drying, is known as *ufa*. There is one peculiarity about cassava that commends it to those tribes who are in danger of attack from their neighbors, which is that the crop never matures all at once, so that while some tubers are fit for use many others are not worth seeking, and offer no temptation to plunder. Cereals, on the other hand, ripen at a certain season, and the whole crop may be carried off at once, leaving the growers in a state of starvation.

A traveler in the Mukondokwa valley, near the Zanzibar coast, mentions *Amaranthus melancholicus* as making a good salad, and "forming trees similar to the copper beech," a statement that needs some elucidation.—*Journal Society of Arts.*

GLOBE FLOWERS.

NATURALIZING garden flowers is a phase of culture happily becoming popular, and among the host of vigorous, yet showy, flowers fitted for the purpose, none are better than the Globe flowers. These have long been cultivated in gardens, and the variety among them now to be had, both in size of flower and shade of color, will satisfy the tastes of all. The flowers of the European species herewith illustrated are clear yellow, while there is every shade between this and the deep orange of T. japonicus. All are strong growers, able to hold their own with rampant growing perennials. The ground for Globe flowers simply requires to be broken up, and a little manure added if necessary to give them a start. At a friend's place the other day I was much struck with the quantities of Marsh Marigold which I saw growing by the side of a small lake, the effect of which was charming; it does not necessarily require water to grow in, although it will thrive all the better if the ground in which it is placed is a little damp. Epilobium angustifolium and the variety album, stately growing plants,

THE GLOBE FLOWER (TROLLIUS EUROPÆUS).

have also a grand appearance growing in a semi-wild state, and if left for a few years undisturbed, they gain in strength in a wonderful way.—*K., The Garden.*

WHAT SORTS OF WHEAT SHALL WE CULTIVATE?

By F. SCHINDLER.

INNUMERABLE experiments have shown that the value of wheat for seed increases with the size of the grain; the larger kernel yields a stronger plant, and this will bear a heavier crop; the smaller grain contains the larger proportion of gluten, yields a better flour, and brings a higher price; but with the smaller yield per acre the profit may be less. The volume weight is dependent more on the well rounded form of the grain than on its size; when about alike in respect to shape, the market value of the grain is closely proportionate to its weight per bushel. Grain of a higher specific gravity is usually richer in gluten. Richness in this constituent is of the greatest importance, as affecting the market value of the grain; it gives better baking qualities to the flour, besides a higher nutritive value, and is accompanied with greater richness in phosphate, also an important constituent of animal food. The proportion of gluten in wheat is determined largely by the climate, and especially by the proximity of the sea. Insular England produces a wheat grain with high absolute weight, but as a rule with less gluten than the wheat of Eastern Europe. English wheat and wheat in general grown in an ocean climate seldom contains over ten per cent. of gluten, while in Eastern Europe and in the Western United States the proportion rises to twenty per cent. and above. Vigorous English seed wheat sown in Eastern Europe yields larger crops than the native seed, and a grain richer in gluten than the parent, though not so rich as wheat from native seed.—*Bied. Centr.; Ag. Science.*

BROWNING OF STEEL AND IRON.

A PROCESS having this end in view has been recently patented in Germany by Mr. A. De Meritens. The goods to be browned form the anode of the bath, which consists of ordinary or distilled water. The cathode is formed by the vessel which contains the water, if it is made of iron; otherwise a plate of iron, copper, or carbon is placed in the bath. The water is kept at from 160° F. to 180° F., and the tension of the current must be sufficiently great to decompose the water. The oxygen which thus is given off at the anode forms in an hour or two a layer of the black oxide of iron (a combination of ferrous and ferric oxide), which is said to polish up very well. Steel is said to give the best results; in the case of cast and wrought iron, the oxide of iron formed separates as a powder; and it is necessary to use distilled water in order to obtain a layer which will adhere to the goods.

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