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VON MILLER'S STATUE OF COLUMBUS FOR ST. LOUIS.

THE saloon on the lower floor of the Art Association Building of Munich lately contained a bronze statue of Columbus, modeled and cast by Ferdinand von Miller. The Munich artist understood well the happiest way to treat his subject. He showed the discoverer of America standing on the highest part of his ship, leaning on the capstan, and holding Behaim's map in his hand. Columbus gazes with emotion on the New World, which rose from the waves at the horizon on the 14th of October, 1492, thus fulfilling the dream of the bold seafarer. This grand new work of the Munich sculptor, which is boldly and artistically modeled, is not only a new proof of the extraordinary gift of the master, but it is also a triumph of German art. This will be the first monument erected to Columbus in the land discovered by him, and it was left to a German to embody in the proper form this late tribute of thanks and admiration.

Mr. Henig Shaw presented to the city in which he lives, besides the Botanical Garden, the beautifully laid out Tower Grove Park, and, as an ornament for the latter, he donated the statues of Shakespeare and Alexander von Humboldt, modeled and cast by Ferdinand von Miller; and soon this beautiful new specimen of the skill of the German artist will decorate these pleasure grounds. The statue will stand ten feet high, on a pedestal richly ornamented in relief. This is also the work of a German artist, Prof. Rohmeis, the architect.

This beautiful work of Von Miller received the unanimous approval of connoisseurs, and the attention of the spectators was so riveted by the lifelike representation that the work of the artist was forgotten in the subject.

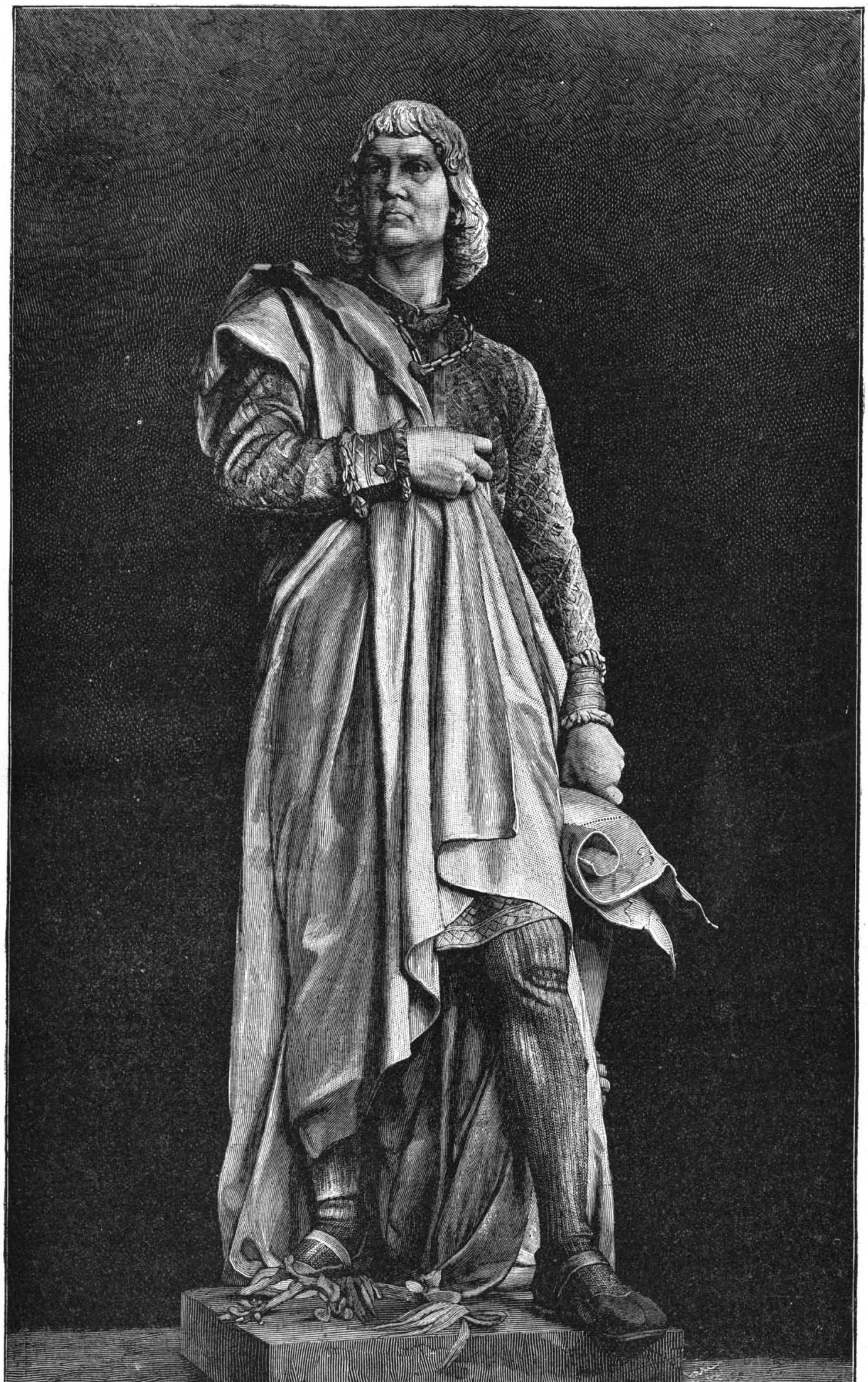
Von Miller is well known in America, and, as before stated, this will not be the first work of his hand to cross the ocean. His name was made familiar to Americans as long ago as 1870 by the great fountain for Cincinnati, the beautiful figure groups of which were modeled by Ferdinand von Miller and A. von Kreling.

Von Miller has completed many successful works of art, among which we can mention the monumental fountain for Bamberg—at the unveiling of which the first degree of the Bavarian Order of St. Michael was bestowed upon the artist—the colossal statue of Albertus Magnus, the statue of General Mosquera for the capital of Colombia, the figure of a Southern soldier for Charleston, the monument of Bolivar for the Panama Canal, and others, which we have not space to mention here; and yet what he has done for the good of his native city, and for the prosperity of the great society of Munich artists, may be considered his greatest work.

The name of Von Miller was made familiar in the art city of Bavaria before the time of Ferdinand by his father, who for so many years was the leader in bronze casting, and was the founder and organizer of this branch of Munich art.

Ferdinand von Miller was born in Munich July 8, 1842, and received his education at the Royal Academy. Afterward he spent considerable time in Paris, where he had an opportunity to study the progress of casting in the great foundries there; a sojourn in Berlin and a visit to the studio of Hahnel, in Dresden, completed the studies of the sculptor. The years 1866, 1870, and 1871 found the young artist fighting as an officer in the ranks of the German army. The peace which followed called him to work on the great monument which was erected on the Niederwald. The statue of Germania, modeled by Von Schilling, was cast in the Munich foundry by Ferdinand von Miller and his brother Ludwig.

Now, at the height of his powers, honored and respected by a wide circle, Ferdinand von Miller may look back with proud confidence upon the work which he has already accomplished, and his native city may look upon him as the promoter and preserver of her greatest good.—*Illustrirte Zeitung.*



STATUE OF COLUMBUS FOR THE CITY OF ST. LOUIS.—BY FERDINAND VON MILLER.

THE MANUFACTURE OF TERRA COTTA AND ENCAUSTIC TILES.

ABOUT thirty years ago, the authorities at South Kensington revived the use in England of terra cotta and architectural pottery in designing the magnificent group of buildings which have been erected in that neighborhood. Since then the fashion has been followed in several provincial towns, but nowhere more extensively than in Birmingham. This town, by its early and successful application of the act authorizing local authorities to purchase and reconstruct local areas, set an example worthy of the emulation of other municipal bodies; and much of the brightness and cheerfulness which is admittedly a pleasing characteristic of new Birmingham owes its existence to the judicious introduction of terra cotta into public and private buildings in the central portions of the town. It being considered that Stafford and Worcester are preeminently counties where clays suitable for ceramic purposes abound, it is not surprising that this branch of industry found adequate representation in the recent Industrial Exhibition, and that the display made of this ware by Messrs. Gibbons, Hinton & Co., of Brierley Hill, was the object of some attention and comment. Terra cotta may be considered a superior variety of brick, each piece of which is specially modeled by means of a mould; like brick, it is excellent or inferior according to the quality of the clay of which it is composed. A clay suitable for terra cotta may be defined as an inferior or bastard fire clay. Fire clay is a material which is required to withstand high temperatures without shrinking excessively or undergoing incipient fusion during repeated firings. Terra cotta, on the other hand, having been once well burned, is not again subjected to heat, and should, in course of manufacture, undergo incipient fusion to an extent sufficient to cause the particles of clay to cohere and to partially fit together, but not to allow of distortion from the form of the model. It is, therefore, evident that the qualities which recommend a clay for the fabrication of architectural pottery condemn it as the groundwork of structures intended to resist the intense and protracted action of fire. In practice, the nature of the plastic substance varies according to the end in view, and mixtures of clay are much employed. Speaking generally, the custom in the Midlands is to mix a bastard fire clay with surface clay of superior quality, and with sufficient red marl to supplement the fusible ingredients, and to supply oxide of iron when necessary for the production of a red tint in the ware. From the average of a number of clays and clay mixtures used for terra cotta, it appears that a composition of about 55 per cent. of silica and 25

per cent. of alumina associated with 4 per cent. of lime, magnesia, and alkalies (taken together) is the most suitable. The latter are the fluxing ingredients of the clay, and vary considerably among themselves in individual samples; a high content of lime and magnesia with low alkali being equivalent to a low percentage of alkaline earths, with potash and soda present to greater, but still moderate, amount By proper treatment of such a basis, terra cotta can be made of the highest constructive quality, and possessed of minimum porosity with great hardness and resistance to compressing and crushing strains. Clay is usually quite hard when found, and sometimes it is necessary to blast for it, as in coal getting. Before it can be used for pottery, it undergoes the process of weathering, which consists in allowing it to lie exposed to the atmosphere for some months. During this time certain changes go on, the nature of which is not quite clear. At any rate, the clay becomes soft and pliable, and acquires the perfection of that quality so peculiarly characteristic of clay which we term plasticity. Probably the decay of traces of organic matter has an influence in promoting the change; but it is certain that after the weathering the material possesses qualities of which it was devoid when mined.

The first operation in the fabrication of terra cotta and encaustic tiles is carried on in the "blunge" pot. This is simply a hole of semi-cylindrical or other shape, excavated in the earth, and lined with brickwork. Into this the clays suitable for the work in hand are put, together with sufficient water to make a thin mud; and the whole is then thoroughly mixed with a wooden instrument called the "blunger." This mud is called "slip." The stones, pyrites, and lumps of iron ore settle to the bottom of the pot. From the blunge the slip is pumped through lawn sieves of varying degrees of fineness. For tiles and small pieces of choice terra cotta, a fine mesh is employed; for coarser purposes, it is advantageous to substitute a gauze allowing much larger particles to pass.

For terra cotta blocks of some magnitude, it is the custom to use a coarse clay, mixed with broken and roughly ground ware that has already been fired. The function of this, which is termed "grog" or "grit," is to prevent cracking and excessive shrinking in the bisque kiln. Sand is sometimes employed for this purpose. After passing the sieves, the slip goes into a vat, and is afterward run into the slip kiln. This may be defined as a flue with a flat top, upon which the slip is dried by the agency of a fire within the flue. For terra cotta and plastic made tiles, the slip is dried until sufficiently plastic to be easily moulded. But before undergoing the last named process, it is carried to the pug mill, where it is subjected to a process of kneading by short revolving arms, in order to break up and mix any dry portions from the bottom of the kiln, and render the whole mass perfectly homogeneous. Grog, when used often, goes in at this stage; colors, however, are always mixed with the clay in the blunge pot. Plastic tiles and terra cotta are moulded from the damp clay after pugging; but many tiles are made by Prosser's process, being worked in a nearly dry condition in the manner subsequently described.

An alternative method of preparing clay from slip is by means of a filter press, which pumps the liquid mass through a series of chambers lined with cloths. These retain the solid matter, and allow the water to pass through the press. The above are simple and effective methods of preparing clay, but the exact details vary according to the circumstances and to the size of the establishment. The blunge pot, which in a small works is a simple tank worked by a wooden blunger, in a large works may be of octagonal shape, or consist of three conjoined and intercommunicating circular tanks, worked each by a blunger, these being geared into a common center and actuated by steam. The articles are made from the prepared clay, either by modeling or pressing in moulds. The first method is employed for the execution of objects of art, and the latter when blocks or architectural ornaments are being reduplicated to a pattern in common.

The work of the artist in clay is beyond our present purpose, and we shall, therefore, only say that the finished model is submitted to the same treatment that awaits the moulded article. Moulds are made of plaster, and in segments so arranged that they easily come asunder without causing disruption of the contained clay, and when this takes place they are said to "leave" properly. If the object is a block that has to take share in bearing weight in an edifice, it is usually solid. Clay for such blocks is carefully prepared, to avoid distortion from the escape of air and steam during firing. At the time of building the Albert Hall, this difficulty was met with; but it was overcome by drilling holes through the wet blocks at regular intervals. These holes, of course, opened on the bearing surfaces, and gave vent to the air and water necessarily expelled from the clay upon ignition. Pieces of terra cotta designed for ornament and not for weight carrying are made hollow, but are often strengthened by bands and struts of clay inside. Such pieces are much easier to fire than those consisting of a solid mass of material.

The block or tile has next to be dried, and this cannot safely be done very rapidly. The drying is conducted in a room of good size, maintained at a temperature of about 70° F. by a system of flues. The time required varies with the nature of the article, ordinary blocks and large tiles needing about fourteen days. When the clay is thus freed from moisture, and is, in the ordinary sense, dry, it still retains the power of becoming plastic if remoistened. Such dry clay contains water combined with the silicate of alumina, and the firing expels this. Burnt clay cannot be made to recombine with water; it has lost its plasticity for ever. But before describing the fire process, it will be convenient to say a little more about the moulds, and the exact procedure in shaping encaustic tiles. The moulds are of plaster of Paris, and considerable artistic and technical skill is necessary in their preparation. They are worked either wet or dry; their employment in the latter condition will necessitate no comment, but manipulation with wet moulds must be described. Although thoroughly wet plaster adheres to clay, the material, when at a certain stage of wetness, allows the plastic substance to leave it readily. The skill of the moulder enables him, by working several duplicate moulds, to insure that each shall be at this stage when its turn comes. Four tile moulds are sufficient for this purpose, two being always in use and two drying. Many tiles are shaped in a nearly dry condition by what is called Prosser's process. The water is completely expelled from the slip on the kiln, and the dry powder is ground beneath edge runners. It is then thrown upon a pavement, sprinkled with water, and allowed to remain until slightly but uniformly damp. It is next compressed between steel dies by a powerful screw, until the clay has taken a sharp impression, when an upward movement of the die bottom, effected by a lever, raises the tile from its bed. Tiles so fabricated, of course, require very little drying, and Prosser's method is very suitable for plain and cheap goods. The dies, however, must be necessarily more expensive than plaster moulds, and the dust method does not lend itself so readily to ornamentation as does the older one. Arrived, by whatever course, at the stage of dryness, the terra cotta has now only to be fired in a kiln closely resembling the ordinary pottery biscuit oven. This type of furnace will come under notice on a future occasion. Large blocks are fired in the open, but tiles and smaller pieces of terra cotta are inclosed in seggars. These are fireclay boxes, in which the articles are burnt while embedded in sand. In firing ware it is necessary to avoid the action of reducing gases and the direct contact of flame. The blocks and seggars are, therefore, built up to form cupboards in the kiln, which exclude flame and smoke, but attain to a suitable temperature by the general radiation and conduction of heat. The kiln comes to its full heat in about four days, and takes some days further to cool, the whole time occupied being about a week. If any reducing action goes on, the color of all articles containing iron is deteriorated; buff terra cotta assumes a gray tint, while the red becomes dingy, from the formation of protoxide of iron. The appearance of the clay before burning is no indication, except to an expert, of the color it will finally assume. The distinction between red and buff terra cotta is due to the greater or less amount of iron present. With some clays it is usual to add a ferruginous marl, to impart a deeper shade to red terra cotta.—*Industries.*

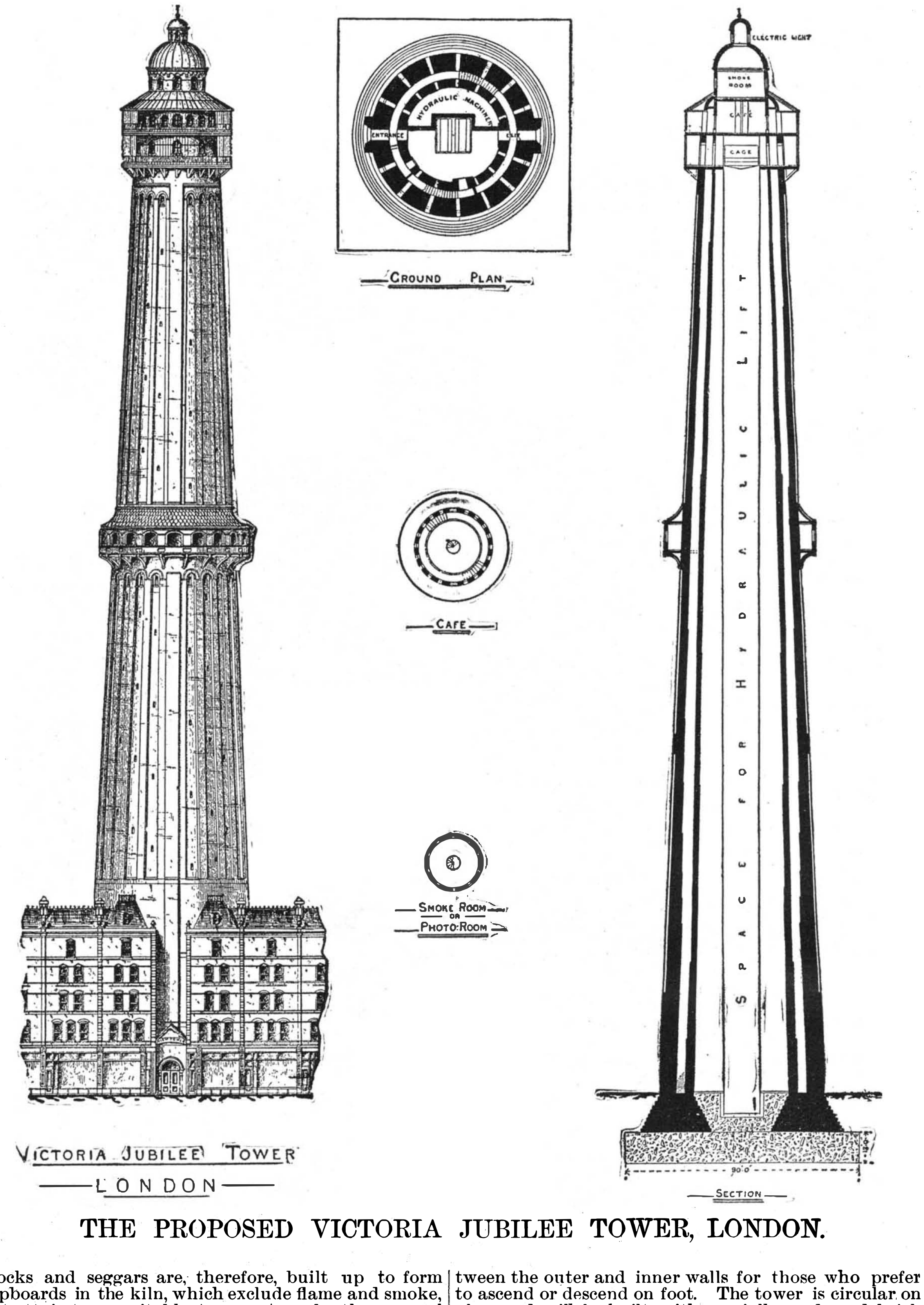
THE latest method of waterproofing consists in passing the sheet rapidly over and in contact with the surface of a solution of oxide of copper in ammonia, by means of properly placed rollers moving with speed. On leaving the solution, the paper is pressed between two cylinders, then dried by ordinary drying cylinders, such as are in every paper mill. The action of the solution is to dissolve the cellulose of the paper to a very slight degree, and to form an impenetrable varnish.

VICTORIA JUBILEE TOWER.

WE illustrate this week a design by Mr. W. H. Radford, A.R.I.B.A., of Nottingham, for a view tower which is proposed to be erected by a company on land belonging to the Marquis of Salisbury in St. Martin's Lane, near Trafalgar Square. The plans are now being considered by the Metropolitan Board of Works.

The object of the company is to celebrate her Majesty's jubilee by the erection of a monument which shall enable colonial visitors and others to obtain without exertion a view of the greatest city in the world, and at the same time the promoters believe that a large profit will be made through the charges for admission.

The height of the tower will be 420 ft. above the pavement, which is higher than any other building in England. The diameter at the top will be 30 ft., at the bottom 60 ft., and the foundations will be 90 ft. square. There is believed to be a good foundation at the site selected, and the pressure on the London clay will only be 2½ tons per foot. A hydraulic lift will be provided in the center by which sightseers will be taken to the top; and as the weight of the people descending will be utilized to raise others, very little power will be required. Two stone staircases will also be provided between the outer and inner walls for those who prefer to ascend or descend on foot. The tower is circular on plan, and will be built with specially made red brick piers, with white brick panels, the gallery and top being of stone. The outer wall is 7 ft. thick at the bottom and 2 ft. 3 in. at the top, and designed so as to have an equal pressure per square foot throughout its height. Outside galleries are provided half way up the tower and at the top. There is a cafe at the top, and also a room in the dome which will either be used as a smoke room, camera obscura, or photographic room. The top may be used also as a lookout for the detection of fires or for other purposes. About 600 people could enjoy the view at one time. The galleries are railed in so as to prevent accidents.



THE PROPOSED VICTORIA JUBILEE TOWER, LONDON.

It is believed the site selected will give the best possible view of London; and as about 50,000 annually undergo the fatigue of ascending the "Monument," it is thought that very large numbers will be glad to avail themselves of an easy ascent to a much greater elevation.

The idea is not new, as an iron view tower with hydraulic lift has been for some years in successful operation in New York; and an immense one is to be erected at the Paris Exhibition.

It is intended to make the building as ornamental as is consistent with such an expenditure as will secure a proper return for the capital.

Sir F. J. Bramwell, F.R.S., Past-President Inst C. E., has consented to act as consulting engineer during the erection of the tower.—*Building News.*

THE FIRST PROJECT FOR A ONE THOUSAND FOOT TOWER.

AT the time of the Philadelphia Exhibition, the Americans conceived the idea of constructing a tower a thousand feet in height, but the project was never carried out. In 1832 the vote on the reform bill suggested to Trevithick the idea of perpetuating the memory of the event by the erection of a column higher than any that had ever up till then been constructed. The celebrated English engineer drew up the following note, which was inserted in the *Morning Herald* of July 11, 1833:

National Monument in Honor of Reform.—The

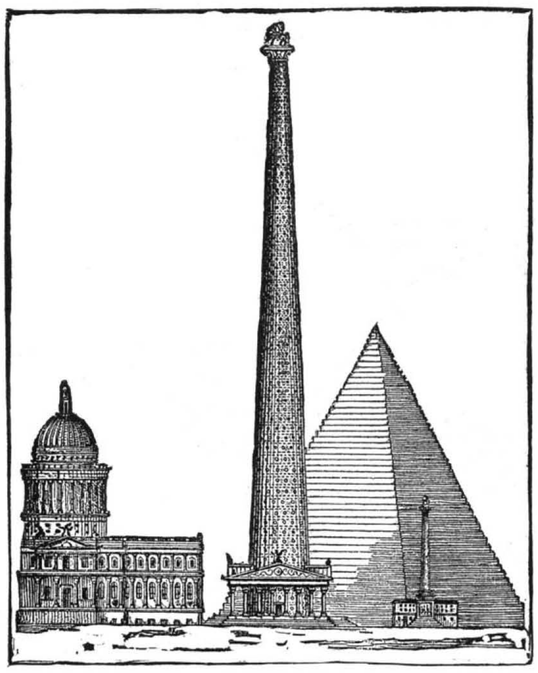


FIG. 1.—A 1,000 FOOT TOWER PROJECTED IN 1832.

great measure of reform, which has become the law of the country, should be recalled through the construction of an extraordinary monument exceeding in height Cleopatra's Needle and Pompey's Column, and symbolizing the beauty, strength, and unalterable grandeur of the British Constitution. With this end in view, it is proposed to hold a meeting for which a special call will be made, and there will be opened throughout the entire kingdom a subscription to which will be admitted even the smallest sums, with a maximum of two guineas.

This note was followed by the names of eminent persons who had given their approbation. The description of the monument was thus given:

"We give a sketch of the 1,000 foot openwork cast iron column, 100 feet in diameter at the base and 12 feet at the apex, consisting of fifteen hundred 11 x 11 foot plates, containing a circular depression in the center 6 feet in diameter, and, near each angle, an aperture 1½ feet in diameter, the object of such openings being to reduce the weight and to diminish the effect of the wind.

"These plates will be 2 inches in thickness, and will have flanges on the sides so as to permit of their being united by bolts, with the interposition of strips of lead. This column will rest upon a circular foundation, with a base 60 feet in height. It will have a cap with a platform 49 feet in diameter, and will carry a statue 39 feet in height. In the center of the column there will be a cylindrical tube 10 feet in diameter, for the reception of an elevator.

"Each plate will weigh about three tons, so that the total weight may be estimated at 6,000 tons. A 20 horse power steam engine will be sufficient to elevate one plate to the entire height in ten minutes, and, as it will be possible to employ a large number of workmen at the same time in assembling the plates, one plate

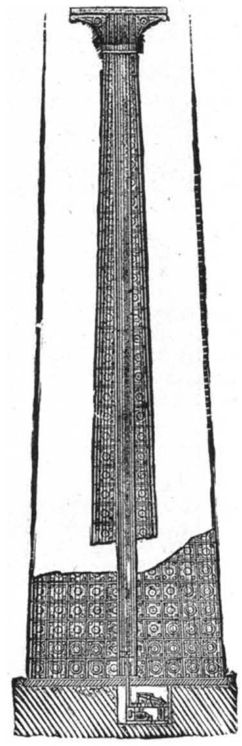


FIG. 2.—SECTION, SHOWING ELEVATOR.

per hour may be easily put in place. The 1,500 plates, then, may be assembled in a little less than six months. Certain foundrymen have engaged to deliver these pieces on the spot at $35 per ton. At such a price the construction of this national monument would not cost over $400,000.

"As stated, there will be a tube 10 feet in diameter, in which will move an iron plate piston provided with seats for twenty-five persons. This piston will be raised by compressed air, through a pump actuated by a steam engine, with an ascensional velocity of about 3 feet per second, so that the entire ascent will require about five minutes. At the base of the tube there will be a door opening outwardly and inwardly to allow persons to enter who desire to ascend. When once this door is opened, the pressure of the air will keep it so. The piston will be provided with an aperture and a cock, serving to regulate the descent by allowing the air to escape.

"The aperture will be such that the descending velocity shall not exceed 10 feet per second. Under such circumstances, there will be no greater shock upon reaching the bottom than that which would be experienced by an object falling from a height of 8½ inches, or than that which would be experienced by a person walking at the rate of 118 feet per hour and suddenly stopped. At London, the 213 foot column called the Monument is much admired. People ascend 419 feet to reach the cross of St. Paul's Cathedral, and daring tourists make an immense climb to scale the 490 feet of the pyramids of Egypt.

"How much more agreeable would it be to ascend a thousand feet on a cushion of compressed air, to contemplate London at one's feet, and to descend again to the ordinary level of daily life, gently and without shock, at a moderate velocity regulated by the simple opening of a cock, without anything being able to accelerate such velocity beyond 3 feet per second, and allowing the traveler to be set down at the end of the trip without receiving any greater shaking up than he would if he were descending a stairway?"

A few meetings were held, and the project in a few months was sufficiently advanced to make it possible to present the plans to the King of England, William IV., on March 1, 1833. But Trevithick died on the 22d of April, and the 1,000 foot column was forgotten. It is of interest from a historical standpoint to recall the matter.

The *Bulletin* of the Society of Civil Engineers, from which we borrow these data, adds: "Far from depreciating the merit of our colleague, Mr. Eiffel, our object has been to show, through the distance that separates the latter's well elaborated project from Trevithick's sketch, the immense progress that has been made during the last half century in the use of metals in constructions."

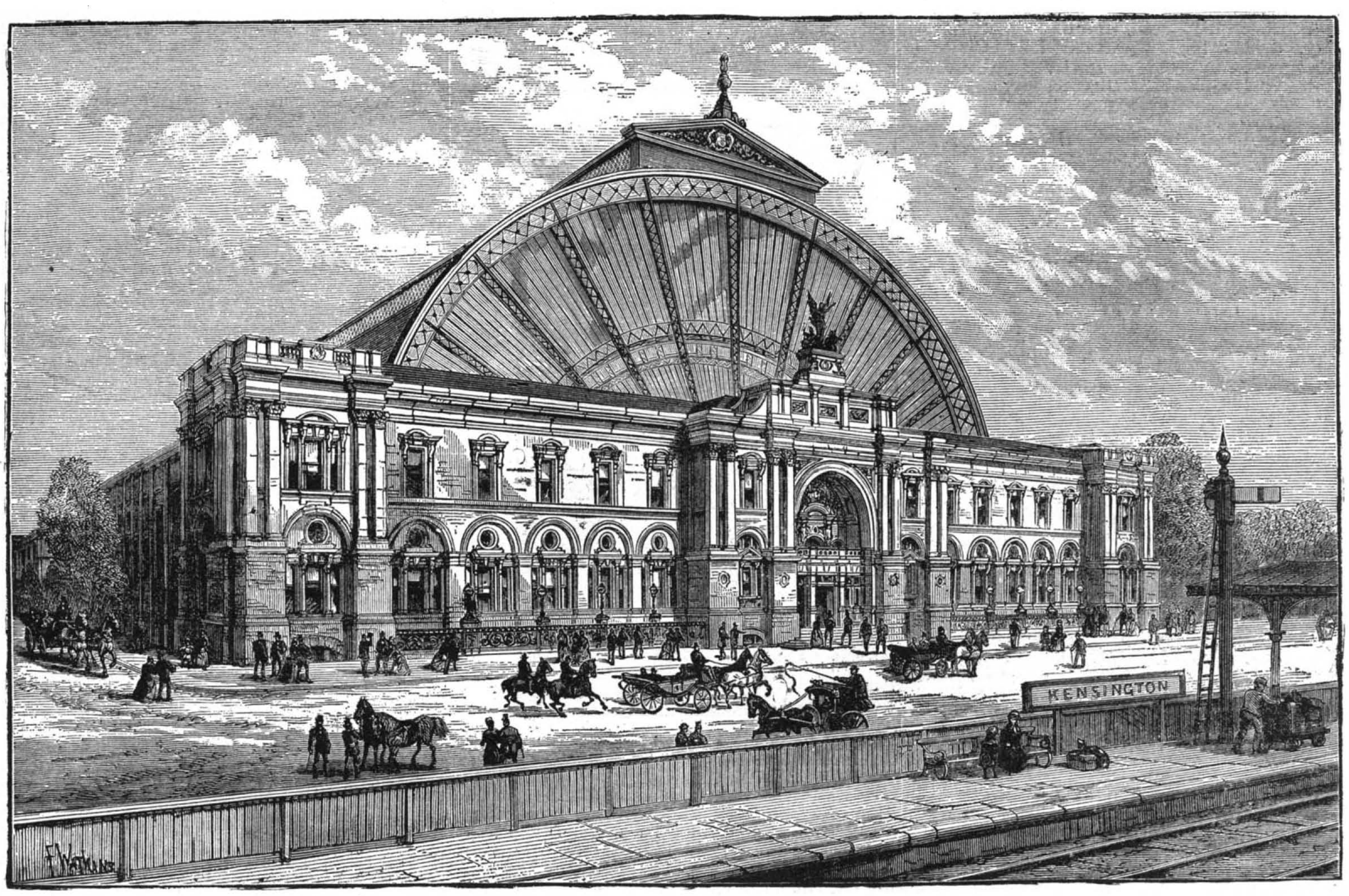
For our part, we shall add that Mr. Eiffel's monument appears to us to be one of the most important projects of our epoch.—*La Nature.*

OLYMPIA, WEST KENSINGTON.

CLOSE to the West Kensington or Addison Road Station of the Metropolitan District Railway, on its western side, a few yards from the Hammersmith Road, a large range of buildings has been erected by the National Agricultural Hall Company, which is intended not only for exhibitions similar to those held in the Agricultural Hall at Islington, of live stock, cattle, horses, and dogs, but also for military tournaments, performances of horsemanship and gymnastic feats, and other public entertainments requiring space, and for a great variety of recreations. These buildings together cover an area of four acres, and will be popularly known as "Olympia."

The grand hall, two acres and a half in extent, is the largest hall in the kingdom covered by one span of iron and glass. It is 450 ft. long by 250 ft. wide, including an outer parade 40 ft. wide, affording a total ground floor area of 109,750 superficial feet, or nearly one half greater than the area of the Agricultural Hall at Islington. The galleries over the outer parade contain 46,000 superficial feet of floor space. The central area on which the performances take place is nearly a third of a mile in circumference. A minor hall forms an annex to the grand hall, and can be used separately for exhibitions, concerts, balls, theatricals, musical or other entertainments, while connected with the galleries will be spacious salons for lecture rooms, picture galleries, refreshment rooms, public and private dining rooms, and offices.

The open gardens, comprising five acres and a half, are immediately adjacent to the hall. They will be devoted to fashionable gatherings, garden and floral fetes, musical promenades, and outdoor sports. One special feature of the company's programme will be high class musical performances in the open air, and Olympia will be in constant use, summer and winter, for any and every class of indoor and outdoor amusement, instruction, and recreation of a high style and character.



OLYMPIA, THE NEW NATIONAL AGRICULTURAL HALL, WEST KENSINGTON, LONDON.

The facade overlooking the railway presents a handsome combination of red brick and white stone, and it is expected that an arrangement may be effected with the railway by which a broad and commodious road may be laid out in front of the new building from the station up to the Hammersmith Road. The station and the building will be connected by a short covered way, so that passengers by rail to Addison Road may pass directly into the hall in any kind of weather without inconvenience.

The hall is covered in by an iron roof, in which many ingenious novelties in engineering detail have been introduced by its designers. The structure consists of semicircular arched ribs 7 feet deep, and 170 ft. clear span, placed 34 ft. apart, and having a clear height from the floor to the crown of the roof of about 100 ft. It constitutes the loftiest iron and glass roof yet erected in or near London, the Crystal Palace excepted. The original architect was the late Mr. H. E. Coe, whose work has been completed by Mr. Edmeston. The contractors are Messrs. Lucas & Son. The engineers for the ironwork were Mr. M. Ende and Mr. Walmiston, and the contractors for it were Messrs. Andrew Handyside & Co., of Derby.—*Illustrated London News.*

OUR BUILDING STONE SUPPLY.

By GEORGE P. MERRILL.

THAT upward of $25,000,000 is invested in the stone quarries of the United States is doubtless scarcely realized by the majority of persons.

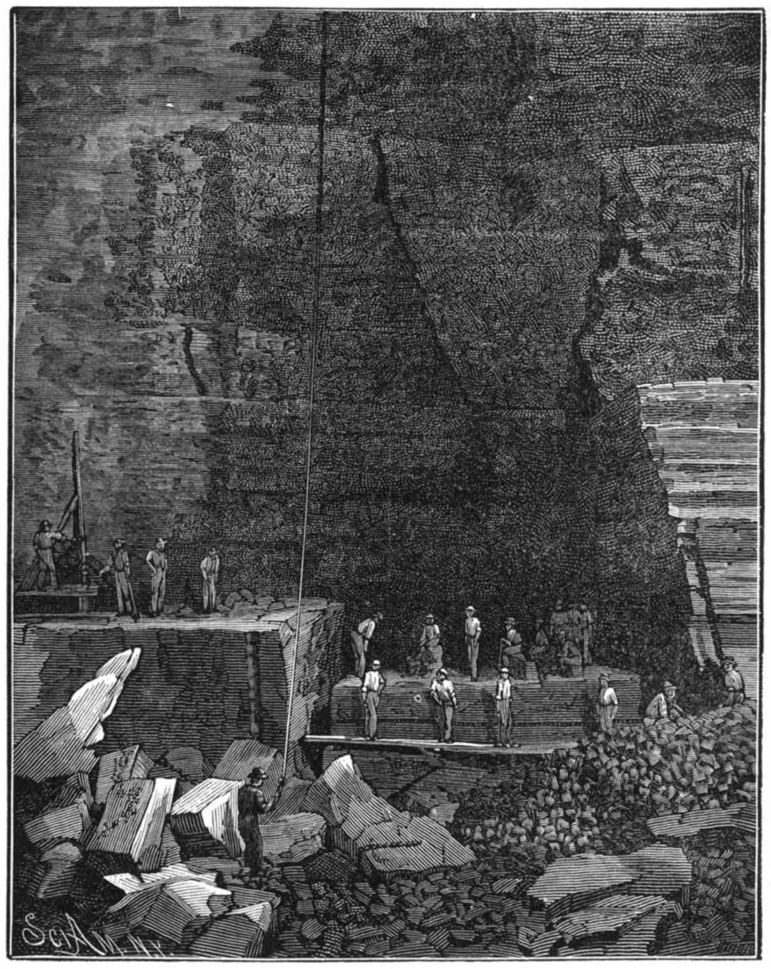
Building stones are of themselves so unattractive to the ordinary observer, and the methods of quarrying and working so laborious and uninteresting, that one is apt to ignore utterly the source or origin of the material, and admire it only in its finished state. Few of those who admire the beautiful work of the sculptor's hands, or the genius of the architect and builder, as displayed in some elegant brownstone or marble front, give even a passing thought to what the material of construction really is, and what its original source may have been.

Yet if he who passes along the principal streets of any of our large cities will but for a moment consider how literally incased he is by stone walls, stone pavements under his feet, stone houses on either hand, he will at once become impressed with the fact that somewhere must exist vast resources to supply this enormous quantity and great variety of material, and large business interests be involved in its production and preparation for the market.

But until the publication of the returns of the tenth census, it is doubtful if any but those actually engaged in the preparation of this work fully realized the extent of the industry. From this report it appears that during the year ending May 31, 1880, there were in active operation in the United States 1,525 quarries of building and ornamental stones of all kinds,* representing an invested capital of $25,414,497, and giving employment during the busy season to upward of 40,000 men. The total product of the combined quarries was 115,380,133 cubic feet, valued in the rough at $18,365,065.

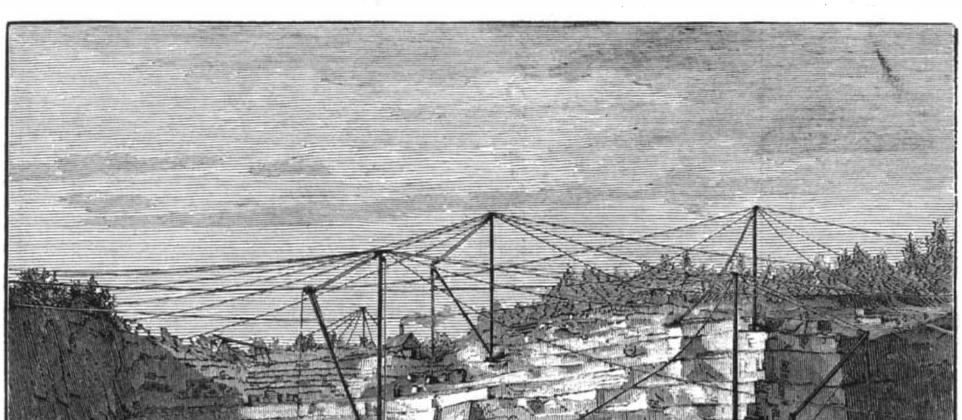
Granites came first into use in this country, probably more on account of their ready accessibility than from any desire on the part of the people for so refractory a material, the matters of transportation and cost of working being then as now the controlling items in deciding what substances were to be employed. As early as 1650, a building long known as the "stone house of Deacon John Phillips" was erected in Boston from rough stone found in the immediate vicinity or brought as ballast from England. Another early stone building was the "Old Hancock House," which was constructed from bowlders of Braintree (Quincy) granite. Neither of these is now standing. In 1749–54 Kings Chapel, which is still standing on the corner of School and Tremont Streets, was erected. This also was of bowlders of the Quincy stone, and was a seventy times seven days' wonder to all who beheld it. Considering the methods employed in getting out the stone, it was indeed a remarkable structure, for we are told that the bowlders were broken by first heating by fire, and then letting fall heavy iron balls upon them from a considerable height. Crude as was the method, the building still stands in a better state of preservation than many that have been erected since; and singularly enough, the wonder does not seem to have been that the stone could be worked at all by these means, but rather that enough good stone was obtainable, and it was universally conceded that enough more like it could not be found to build another!

The granite bowlders dotting the Quincy commons continued to furnish for many years the chief stone used in the vicinity for foundations, steps, and like purposes, and were from time to time the subject of State legislation, lest a too indiscriminate use of the material should exhaust the supply. Early in the present century, however, granite began to be brought into the city from Chelmsford or Westford (Hitchcock says the latter), and stone buildings became more common. In 1810 was erected the Boston Court House, in 1814 the New South Church, and about the same time the Congregational House on Beacon Street, the Old Parkman House on Bowdoin Square, the University Hall in Cambridge, and in 1818–19 the first stone block in the city, a portion of which is still standing on Brattle Street.



PORTLAND SANDSTONE QUARRIES—SPLITTING OUT THE STONE WITH WEDGES.

In the above year, stone from the same source was also shipped to Savannah, Ga., for the construction of a church at that place, but this also was obtained largely from bowlders, and such a thing as a permanent quarry systematically worked was almost unknown. The demand for large quantities of stone for the construction of the Bunker Hill Monument caused the opening of extensive quarries in Quincy in 1825, and the construction of what has been called the first railway in America to transport the quarried material. From this date the development of the quarrying industry has gone on constantly and rapidly. It is stated that as early as 1837 the total output of all the quarries of Quincy was 64,590 tons, valued at $248,937, in the production of which some 533 men were employed.



GRANITE QUARRIES, HALLOWELL, ME.

In 1845 the value of the total product had increased to $324,000, although the number of men employed was but 526. In 1855 there appears to have been a falling off, since the value of the product of that year was but $238,000, and but 324 men furnished with employment. Twenty-five years later (1880) the census returns for the town of Quincy and West Quincy showed a total of some thirty quarries, producing annually not less than 723,000 cubic feet of stone, valued at $236,440, and giving employment to some 820 men.

Over half a century of use has made the Quincy granites so well known that I shall refer to their qualities but briefly.

Exceedingly tough and hard, of a coarse texture, and deep blue gray color, they give an appearance of peculiar solidity and strength to all buildings in which they are used, while the fact that they admit of a high lustrous polish renders them peculiarly adapted to the finer grades of monumental and decorative work. For the latter purposes they are coming more and more in vogue, and appearances indicate that with present prices and tastes the days of Quincy granite for merely rough building purposes are over, and henceforth it must be known more properly as an ornamental stone.

Nevertheless, there are few stones that have exercised a more pronounced effect upon American architecture. In Boston alone, out of the 312 buildings with exterior walls constructed wholly or in part of granite, 162 are of the Quincy stone. Figures, if obtainable, would, I am inclined to believe, show a like proportion in other of our Eastern cities.

At about the date of the opening of the "Bunker Hill Quarry" at Quincy, a granite quarry was also opened in the adjacent town of Gloucester, a "town heretofore noted only for its fishery interests," and not long after others were opened at Anisquam, but which were soon after abandoned. Quarries at Rockport just beyond Gloucester were opened in 1827, and are now in a flourishing condition, though the first year's business is said to have resulted in a net loss of $15. The celebrated quarries at Bay View, now the property of the Cape Ann Granite Company, were opened in 1848. This is now one of the best equipped in all its appliances of any quarry in the country. The material, of which there is an annual output valued at nearly a quarter of a million dollars, is coarse, but exceedingly strong, and of a blue gray or greenish color.

To those who have seen and admired the Butler mansion on Capitol Hill in Washington, nothing need be said in praise of the material for massive structural purposes.

To take up the history of the granite industry as it spread out from these few starting points would far exceed the prescribed limits of this article and unnecessarily tax the reader's patience as well. We will then but briefly allude to a few such quarries as have gained a national reputation from the quality of their material, and leave interested parties to seek elsewhere for further details.*

Whoever has taken the delightful sail from Portland, Maine, to Mt. Desert, Grand Manan, and Eastport, cannot have failed to mark the rocky barrenness of much of the coast and the adjacent islands. The "cold gray granite" is everywhere pushing out its unprotected front, apparently alike defying the attacks of man and nature. The rare excellence of many of these outcrops for quarry sites early made itself evident to the shrewd and energetic business men of New England, who were not slow to take advantage of them. It is stated that in 1837, out of 125 acts of incorporation granted by the State legislature, not less than thirty were for granite-working companies, three of which were to be located in the immediate vicinity of Augusta and Hallowell, while the others were to be scattered along the eastern borders of the State, mostly directly upon the coast. The Hallowell granite quarries, being among the earliest, shall first receive our attention. Situated some two or three miles out of the town, the rock lies in the quarries in the form of huge imbricated sheets of all thicknesses up to eight or ten feet. So slightly do they adhere to one another, that it is but necessary to free the stone at the sides by a few drill holes and blasts to obtain blocks of almost any required size. The material is almost

* This does not include the very many quarries of stone used for paving or lime burning, but only those whose product is actually used wholly or in part for building or ornamental work.

* See "On Stones for Building and Decorative Purposes," by this author, now in course of preparation.

white in color, and of so fine and even a grain that it can be utilized for all manner of constructive purposes, excepting, perhaps, interior decorative work. One can but experience a feeling of surprise on passing into the companies' shops to find himself surrounded on all sides by sculptors of American, Spanish, and Italian nativity busily engaged in reproducing from plaster models by dint of hammer and chisel a great variety of imitative forms, not of course excepting the mythical winged figures which in our youth and ignorance of the possibilities of anatomy we have been taught to suppose represent the future forms of those who are sufficiently good in this world to be rewarded in the next. The Hallowell Granite Company have fully demonstrated the fact that the art of sculpture is not limited to the use of one particular material, and it is stated, indeed, that in spite of its increased hardness, a granite statue now costs but little more than one of marble. This is due, however, in part to the fact that less detail is brought out in the granite than when the latter material is used.

Those who imagine that the Egyptian obelisks are among the largest single blocks of granite ever quarried should visit the works on Fox Island, or Vinalhaven, as it is now called, in Penobscot Bay. Here will be found a thriving village of some 3,000 souls, dependent for its prosperity almost altogether upon the extensive granite quarries in the immediate vicinity, and whose proximity is impressed upon the traveler the moment he lands from the steamer at the wharf, by the immense masses of stone lying about in every direction. The rock occurs here in such masses that the size of blocks obtainable is limited only by the means of handling. Single pieces have been loosened from the bed of such size and shape as to make four such pygmy shafts as that transported from Alexandria to succumb to the rigors of an American climate in Central Park, while blocks of 200 tons weight are so abundant as to cease to excite remark. The Wolff monument in Troy, N. Y.—60 feet in height by 5½ feet square at the base—is the largest single block ever finished by this company, or indeed in the United States. But in this case, as in others to be mentioned, the size is governed only by demand and transportation facilities.

To Maine belongs the credit of producing the only red or pink granite that can at all successfully compete in our markets with the imported Scotch granites or those from the Bay of Fundy, New Brunswick, though excellent varieties for general building, and which are used to a less extent, occur in several other States.

The beautiful pink granite used in the construction of the new Trinity Church in Boston is from Dedham, Massachusetts, while the coarser stone used in the new City Hall at Albany was taken from quarries at Milford in the same State. The two beautiful columns of deep red granite in the Senate Chamber of the new Capitol building at Albany are from quarries on one of the Thousand Isles in the St. Lawrence, while the four large pillars of pink porphyritic granite in the Assembly Chamber were furnished by quarries at Leetes Island, Connecticut.

The celebrated Concord, N. H., granites are from quarries in the immediate vicinity of the city from whence they derive their commercial name, and are quarried to the value of some $200,000 annually. This stone closely resembles that of Hallowell, Me., and is used for similar purposes. Although popularly known as the Granite State, New Hampshire ranks but fifth as a granite producer, being preceded by Maine, Massachusetts, Rhode Island, and Connecticut. Granites of excellent quality also occur in the Archæan formations of the Appalachian system as far south as northern Georgia, though they are now but little quarried. Near Richmond, Va., occurs an excellent bed of this stone, which furnished the material for the State, War, and Navy department buildings in Washington.

A coarse red granite, very poor in mica and of excellent quality for massive structures, occurs in inexhaustible quantities in Iron County, Missouri, and is being extensively used in Chicago, St. Louis, and other Western cities, both in polished and rock faced work. Other gray granites, to which we can barely allude for lack of space, occur near Concord, N. H., where they have been quarried for many years.

Ever since the discovery of the wonderfully beautiful effects produced in marbles by the early sculptors and decorators, these stones appear to have been regarded by the people at large with a sort of veneration amounting in some cases almost to fetichism; and any stone to which the name is now applied seems generally accredited with possessing all the qualities of beauty and excellence of those first used. This is, however, far from the case; and while the name includes stones of rare beauty, it is also made to cover others suitable only for general building purposes, and which are perhaps poor at that.

To dream that one dwells in marble halls does not therefore necessarily denote a condition of perfect bliss, but it may be a state of abject misery, since one can scarcely imagine a more dreary material for interior decorations than many of our white and bluish marbles, but which are, nevertheless, used with amazing persistency. Even the crude expression of boyish enthusiasm, designed as a monument to the Father of his Country, that now rears its lofty head out of the malarial emanations of the Potomac flats, was built wrong side out in deference to the state of popular opinion. Interiorly it is of the finest quality of Maine and Massachusetts granite, while exteriorly the dead white marble walls are already seamed and stained so as to be quite unsightly on a close inspection.

From a scientific standpoint, there is no difference between a marble and ordinary limestone or dolomite, the rocks having precisely the same composition and origin, but one possessing such color and structural peculiarities as render it desirable for ornamental or decorative work, while the other through the lack of these same qualities is relegated to the more ordinary purposes of general construction.

Generally speaking, we may say that a marble is a limestone (or dolomite) that has undergone just the right degree of metamorphism to develop in it points of beauty, and render it capable of receiving a smooth surface and high polish. In many of the most beautiful marbles the metamorphism has proceeded only so far as to harden the stone without destroying its fossil remains, while in others these have been entirely obliterated and the rock become crystalline throughout. Little as it seems to be appreciated, it is this crystallization alone that renders so many of the American marbles inferior to those of the French Pyrenees, Italy, and Northern Africa.

Nearly all our native stones of this class are too coarsely crystalline. This not only renders the production of a perfect surface difficult, but the cleavage facets reflect the light from below the surface in such a way as to cause it to be studded with innumerable minute silvery points, quite destroying its uniformity. However good the color may be, a stone of this nature must always rank lower than one that is so fine grained and compact as to appear non-crystalline or amorphous.

Marble, though one of the most beautiful of rocks, has yet a most ignoble origin. At the bottom of some old Devonian or Silurian sea, there accumulated throughout untold ages vast beds of dead corals, shells, and other marine animals, embedded in fine calcareous mud. Throughout succeeding ages these were further buried by sand and mud, to be finally, by heat and pressure, hardened into stone. Not stranger is it that the dust of Alexander be found stopping a bung hole, or that "imperious Caesar, dead and turned to clay, might stop a hole to keep the wind away," than that the slimy ooze of a sea bottom, full of all manner of dead and uncanny things, becomes by nature's processes an object of beauty, admired alike by the most esthetic, fastidious, and vulgar minded.

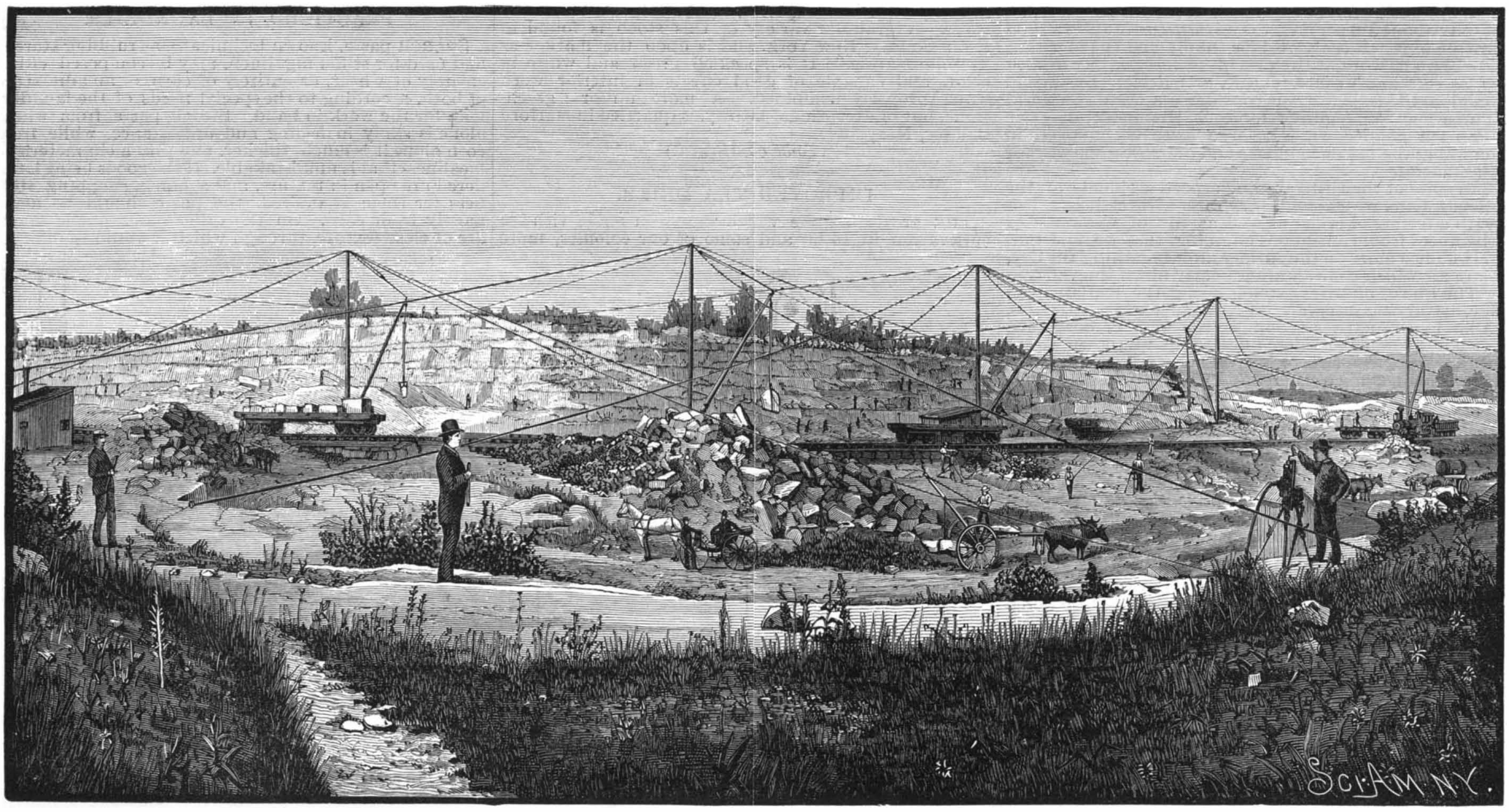
Of the $2,000,000 worth of marbles annually produced in the United States, more than one-half ($1,350,000 worth in round numbers) is from quarries in Vermont, and the remainder nearly altogether from Massachusetts, New York, Pennsylvania, Maryland, and Tennessee.* The material is imported to the value of about $600,000 annually, the supply coming largely from Italy, though smaller amounts are brought from France, Belgium, Portugal, Egypt, and Algeria.

The narrow belt of limestone from which is obtained the supply of Vermont marble extends from a point beyond the Canadian line throughout the entire length of the State, and thence through western Massachusetts and Connecticut to Long Island Sound. Since early in the present century numerous quarries have been opened along this belt, but at the present writing the most extensive lie within the limits of the little village of West Rutland, cozily nestling among the green hills of central Vermont. The quarries themselves, to which the village owes its entire business prosperity, lie along the western base of a low range of hills, which, to the ordinary observer, give no sign of the vast wealth of material concealed beneath their gray and uninteresting exteriors.

In the quarry the stone is found in layers from two to four feet in thickness, often mottled and streaked, and varying in color from pure white to deep blue gray and almost black. These layers, instead of lying horizontally one upon another, are at the surface steeply inclined and almost on edge, so that the same quarry at the same time may be producing marbles of half a dozen grades of color and quality.

In quarrying, the best beds are selected, and upon their upturned edges excavation is commenced; first by blasting, to remove the weathered and worthless material, and afterward by channeling, drilling, and wedging, no powder being used lest the fine, massive blocks become shattered, and rendered unfit for use. The quarry thus descends with almost perpendicular walls to a depth of sometimes more than 200 feet, when the beds are found to curve, and pass under the hill.

In following them, the excavations assume the appearance of vast artificial caverns, from whose smoke-blackened, gaping mouths one would little suppose could be drawn the huge blocks of snow-white material lying in gigantic piles in the immediate vicinity.



QUARRIES OF FLYNT GRANITE CO., MONSON, MASS.*

* W. N. Flynt & Co.'s granite quarries, situated a mile north of the village of Monson, on a spur track of the New London Railroad, were first opened eighty years ago by agents of the United States Government, who took from there stone for the foundations of the Springfield armory. In 1825, Rufus Flynt put four or five men to work in the quarry to supply the local market, and the front of the Chicopee bank building in this city was soon after built of this stone. Since 1836, W. N. Flynt, son of Rufus Flynt, has had charge of the work, and has greatly enlarged the business, until at present the yearly output of stone is 20,000 to 30,000 tons, valued at $150,000 to $200,000. The quarry land owned by the company amounts to 500 acres, all underlaid with granite, only a small part of which, however, has yet been worked. The stone lies in horizontal layers, from one to twelve feet thick, and wedges are mainly depended upon for getting out even the largest masses of rock, powder being only used to lift the loosened layer from its bed. The largest single piece which has yet been taken out was 354 feet long, 11 wide, and 4 high, and 1,104 wedges were used in detaching it. The present workings are on the slope of a hill, and, although 75 feet below the crest of the hill, are above the surrounding country, so that water gives no trouble, and the rock is the more easily handled. From March to December about 100 quarrymen and 40 stone dressers are employed, and during the winter an almost equal force is kept at work. Last year 28,403 tons of granite were shipped, and in all branches of the work between 600 and 700 men were employed.—*Springfield Republican.*

* The census returns give figures for limestone and marble combined. By going over the original schedules I was able to obtain the following approximations for the output of such as are put upon the market as marbles, for the census year:

Vermont	$1,340,000
New York	224,500
Massachusetts	238,125
Maryland	65,000
Tennessee	173,600
	$2,031,225

Some of these have been partially roofed over to protect them from snow and rain, and seem rather mines than quarries. The scant daylight at the bottom is scarce sufficient to guide the quarryman in his work. As one peers cautiously over into the black and seemingly bottomless abyss, naught but darkness and ascending smoke are visible, while his astonished ears are filled with such an unearthly chorus from clanging quarrying machines, puffing engines, and shouting laborers as is comparable with nothing within the range of our limited experience. The reader is therefore permitted to draw upon his own resources if comparisons are essential.

The descent to the bottom of the pit is by means of numerous flights of wooden and suspiciously shaky-looking steps, bolted to the quarry wall. One passes down flight after flight in turn, each time to find himself only on a narrow, wet, and slippery ledge of rock, which serves as a landing to the flight below. At last the bottom is reached, and 200 feet below the surface of our sphere we look up at the gloomy wall of rock overhead, dripping with moisture and black with smoke, with an involuntary shudder of dread lest we are never to find our way to the top again. Everything is cold and dripping wet, and the atmosphere of that heavy, clammy feeling that can be described only by the suggestive word *dank*.

Steam channeling machines moving slowly back and forth over their narrow roadbeds spitefully strike upon the rock clanging blows with long chisels, which rapidly produce deep grooves some two inches in width and of any desired depth up to several feet. Closely after these follow the gadding machines, which drill or bore circular holes along the bottom and sides of the blocks, into which wedges are introduced and the stone split from its bed. The Wardwell channeling machine, which is the one most commonly in use, cuts a continuous groove at the rate of 75 to 150 square feet per day, thus doing the work of from 25 to 50 men by the old hand process. As the expense of operating the machine is only about $10 per day, the advantages of this method are obvious. It is claimed for the diamond gadder that it will do its work at the rate of 180 feet per day in rock of as soft and even a texture as marble. By the old hand methods, 12 feet was considered a fair day's work. Three men are required for each channeler and two for each gadder, while a large force is employed in handling the loosened blocks and preparing the way for the machines.

In spite of their threatening aspect, accidents at the quarries are, we are told, very rare. Nevertheless, it is with a feeling of relief, as well as one of weakness at the knees from continuous climbing, that we find ourselves once more on the surface, and breathing the dry, pure air which comes wafted gently down the valley.

The line of quarries extends along the Rutland valley, at varying intervals, for a distance of several miles. Abandoned quarries abound in the form of deep pits, with perpendicular sides, filled to an unknown depth with dark, greenish-looking water, covered with float-debris and slimy algæ, reminding one of some huge mediæval mote or dungeon, as described by Scott.

The marbles of the Vermont belt, although most excellent of their kinds, are, with a few exceptions, scarcely what the public demands for interior decorations, either on account of their colors or unsatisfactory textures, but are largely used for general building, counters, tiling, and monumental work. The Vermont statuary, although of soft and even grain, and a beautiful stone to work, is of too dead white a color, lacking the peculiar translucency and waxy appearance of its Italian prototype. Other important stones, which must not be passed over unnoticed, are the very hard, close-grained red and white "Winooski" and "Lyonaise" marbles from Malletts Bay and Swanton. These are much used for tilings, and are susceptible, in proper combinations, of good effects in decorative work. But as displayed in the halls of the new Capitol building at Albany, the effect is anything but satisfactory. The fault here, however, is largely due to improper care in selection and preparation of material.

The marbles of New York are also largely suitable only for general building, owing to this same defect. Two varieties from Chazy and Plattsburg, in Clinton County, are, however, notable exceptions. In these the process of metamorphism has not been carried to the same extremes as in the Vermont stone, and the resultant effects of pink and red fossil shells embedded in a gray and reddish background are very pleasing. Under the names of "Lepanto" and "French gray," these stones are now in the market, and, with the exception of those of Tennessee, have been more used for furniture and interior decorations than any other American marble.

The finest marble for general decorative work which the country yet affords is undoubtedly that of Hawkins and adjacent counties in eastern Tennessee. Since its first introduction into the Capitol building at Washington, this stone has been a universal favorite, and justly so. In colors varying from light pinkish, mottled with white, through all shades to deep chocolate red, it offers sufficient diversity to suit the most fastidious, while the closeness and compactness of its texture, with almost absolute freedom from flaws, renders the production of larger surfaces, without recourse to the process of filling, than is possible in any other marble, native or foreign, with which the author is acquainted.

The recently introduced marbles from Pickens County, Georgia, although scarcely known as yet in our Eastern markets, are worthy of notice. Like the Vermont marbles, they are rather too coarsely crystalline for the finest kinds of decoration, but the colors are such that they will doubtless be much sought. One variety, of a bright flesh pink, is especially unique, being totally unlike anything else now in the market, though a similar variety is abundant in certain parts of North Carolina, at present not readily accessible.

One of the most unique marbles in this country is found in the beds of Devonian limestone near Charles City, Iowa. The rock is of exceedingly fine and compact texture, non-crystalline, and full of fossil shells and corals. The colors are dull, varying from light drab to brownish, but it acquires a smooth surface and quite uniform polish, showing to beautiful advantage the fossil remains, often six or ten inches in diameter, firmly embedded in the fine drab ground-mass.

It is stated by Prof. Seely that the earliest attempts at systematic quarrying of marble in New England (and doubtless in America) were those of Philo Tomlinson, who began operations at Marbledale, in the town of New Milford, Connecticut, about 1800. Other quarries were soon after opened, and in 1830 as many as fifteen were in active operation, and as many mills for sawing were in operation within a distance of three miles. The product was sent to all parts of the country. Soon after this date competition set in from other localities, particularly from Dover, New York, and Rutland, Vermont, and by 1850 the business had proved so unremunerative that the last quarry was abandoned. Marble quarries and mills were also in active operation at West Stockbridge, in Massachusetts, as early as 1802 or 1803, and these furnished the marble for the City Hall in New York city. Work was stopped here in 1855, owing to competition of Vermont and Italian marbles.

Of the many marble quarries in Vermont, those in East Dorset are believed to have been longest systematically worked, Prof. Seely stating that one Isaac Underhill began operations here as early as 1785, the product being utilized for fire jambs, chimney backs, hearths, and lintels. Other quarries soon opened, and from 1785 to 1841 nine were in operation at this place. The first marble gravestones ever finished in the State are believed to have been the work of Jonas Stewart, in 1770. Prior to the introduction of Italian and Rutland marble, about 1840, the Dorset stone was in greater demand than the supply was sufficient to meet. At West Rutland, works were first put in successful operation about 1838. At the present time not less than fifteen quarries are in operation, affording employment altogether to about 2,000 men.

The so-called "verdantique" marbles are entirely different from those just mentioned, being composed largely of serpentine or of serpentine in combination with calcite. Extensive beds of this rock in the vicinity of Roxbury, Vermont, are capable of furnishing an inexhaustible supply of this beautiful material. Owing to cost of working, however, it is not quarried, although fully equal, if not superior, to the imported Tuscany stone. A granular variety of this stone is found in Essex County, New York, and is upon the market as "ophite marble." It is speckled green and white in color, and capable of good effects in interior work when properly combined. A more uniform greenstone, but of exceptional beauty, is quarried in Harford County, Maryland.

(*To be continued.*)

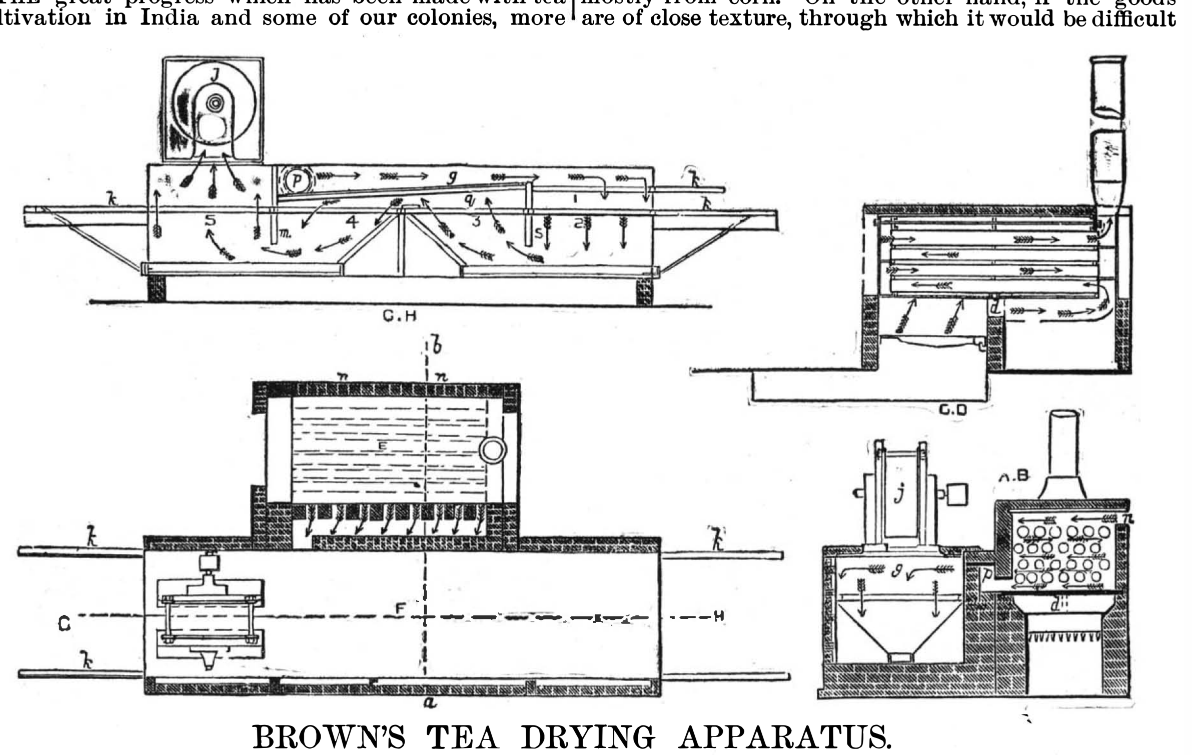
IMPROVED TEA DRIER.

THE great progress which has been made with tea cultivation in India and some of our colonies, more especially of late years in Ceylon, has caused much attention to be given to the subject of machinery for the proper preparation of the leaf. It is of the greatest importance that the teas which reach the home market should suit the public taste, and that issue is, perhaps, more dependent upon the process through which the green leaf is passed than even upon the qualities of the soil whereupon it is grown. Many machines have been devised to meet the needs of tea-curers; and we illustrate, says *The Engineer*, one of the latest, and—as it seems to us—one of the most efficient of such machines that has come under our notice.

The designing of these is by no means a simple problem. The leaf of the tea plant is exceedingly delicate, and its flavor likely to be extremely prejudiced by over or unequal heating. Mr. Brown has, therefore, designed his air heating furnace for location exterior to the building in which the sensitive leaf is exposed in the drier, so that in no way can the latter come into contact with the fumes emitted. The arrangement of the furnace in which the air is heated will be readily seen from the drawings, A B, C D, and E. The air, which is drawn through the whole system by the fan, *j*, enters the furnace at U on section A B; guided by the lock plates inserted between the flue tubes, it passes alternately backward and forward between the rows of tubes, as shown by the arrows, until it enters at a temperature of about 180 degrees—through the orifice, *p*, section G H—the air chamber, *g*, of the desiccating or drying machine. The tea to be exposed to its action is spread upon wire gauze trays, numbered 1, 2, 3, 4, and 5, these being entered by hand upon the projecting rails, K, to the left of section G H, and propelled at suitable intervals until they have passed through the finishing tray plate No. 1.

As will be seen by the direction of the arrows on the same section, G H, the heated air is drawn downward through trays 1 and 2, an evenness of temperature being secured by this method unattainable when the volume of heated air is allowed to ascend by the force only of its relative density. After passing through trays 1 and 2, it is directed upward by the dividing screen, S, and, passing through tray 3, it impinges upon the base plate, *q*, of the hot air chamber, *g*, taking up from this any heat it may have parted with in its passage through the moist leaf in trays 1, 2, and 3. This capacity for reheating is an essential particular of the design. Brought up to the standard temperature once more, the air reassumes a downward course through tray 4, when, deflected by the second dividing screen, *m*, it reascends through tray 5 and passes out through the fan exit. By this method of passing the air through the same tea, first downward and then upward, the leaf is exposed to a thorough current from alternate sides, and its mass dried as effectually as if hand or mechanical turning was employed to spread the leaf.

This mechanism is said to be capable of turning out one hundred pounds of made tea per hour on a consumption of from eighty pounds to ninety pounds of wood fuel. It seems to be singularly free from the complications which accompany the generality of tea driers, inasmuch as there is with it none of the gearing usually employed to keep the tea properly spread and turned. Practical working has shown that the temperature of 180 degrees in no way injuriously affects the tubes of the air heating furnace. These are pushed into the tube plates and packed with a string of asbestos, and the simplicity of such packing enables any defective tube to be readily removed and replaced by another. The air current, however, always passing between the crown plates, *d*, of the furnace and the lowermost tubes, effectually prevents any heating to redness of any of the series, and a burnt tube has been quite unknown hitherto. Several of these machines have already undergone severe tests in Ceylon, where the tea planters appear to be well satisfied with the results obtained by their use.



BROWN'S TEA DRYING APPARATUS.

STARCH AND THE STARCHING PROCESS AS PRACTICED IN LAUNDRIES.

STARCH paste, known technically as rubbing starch, and used for stiffening linen, may be composed either entirely of wheat, or entirely of corn, or an admixture of both, according to the special needs of the laundryman for the work in hand. Starch paste from wheat alone is slimy in feeling and appearance, while from corn alone it is much thicker, and has a characteristic mealiness that is unmistakable. If the goods being laundered are open in texture, and a harsh, snapping stiffness for them is desired, the paste should be made mostly from corn. On the other hand, if the goods are of close texture, through which it would be difficult to work the corn paste, or if the goods, while stiff, should have a toughness that would render the linen less likely to break when folded, then wheat should largely predominate in the paste. For general work, ten ounces of wheat and six ounces of corn to every gallon of water is found to give excellent satisfaction.

The dry starch, after weighing, is put into an ordinary tub, covered with cold water, and the dough thoroughly worked with the hands until entirely dissolved. Much can be learned of the quality of the starch at this stage. The surface of the water should be white and clean. Should the starch be dirty, it will easily be detected in the milky liquid. If a thick foam collects on the surface, the starch may at once be rejected, for, when boiled and allowed to stand cold, it soon breaks down into a watery paste that has no body. Even if rubbed, while hot, into the goods, the same change occurs as they lie being dampened, and as a result, when ironed, instead of having the desired stiffness, the collars or other articles have a soft feeling, are limp, and become blistered as soon as shaping them is attempted. The starch, when thoroughly dissolved, is poured into the tub or kettle containing the requisite amount of water, and actively stirred until the whole is brought to the boiling point, and there it is maintained from forty minutes to one hour. The best results are obtained by using a steam jacket for the boiling operation, as thereby the quantity of water can be relied upon and the consistency of the paste maintained absolutely uniform from day to day.

If boiling is conducted by means of a jet of steam introduced directly into the starch, care must be taken that the steam pressure is always the same, else, however carefully the starch may be weighed or the water measured, a surprising variation in the consistency of the paste will be noticed. It is easy to understand, if one considers it a moment, that steam at, for example, eighty pounds pressure will not only bring the paste to a boiling point quicker, but will maintain the boiling for a given time with much less condensation than if

the steam gauge showed but forty pounds. The hotter and drier the steam, the greater the pressure, are facts too well known to require special elucidation. The evil does not lie in the decreased pressure, for the boiling can be conducted quite as well with the steam at ten pounds, or even less, as if at eighty pounds, provided, of course, that due allowance in measuring the water is made for the increased amount of condensed steam, but it lies in the variation of the pressure. This fact may explain to some why on one day the rubbing starch is all right, and on another, with the same care exercised in weighing and measuring the materials, the starch is soft, watery, and totally unfit for use.

The starch paste, when ready for use, may have a slightly blue tint, and when cold the consistence should be such that it will drop readily from the hand. When worked between the hands, it should retain its body and rub smooth without becoming watery. If there is a sticky, clammy feeling, it possesses a bad fault, and betokens trouble ahead for the ironing room, unless the starchers exercise extraordinary care in "wiping off." Two causes may be assigned for this condition: Either it is poor starch containing an excess of gluten, or it is insufficiently cooked. Paste may be formed at as low a temperature as 130° F., but it is quite a different article from that which has been brought to the boiling point.

Starching consists essentially of three operations, viz., forcing the starch into the several layers of fabric, removing the wrinkles, and, finally, wiping all superfluous starch from the surface, known as "clearing." The starcher spreads the work on the table, covers it with starch, and rubs it quickly to and fro with the palm and fingers of the right hand, the left hand resting on the right, and the weight of the body being thrown upon the arms. At the same time, with the aid of her finger nails, she dexterously moves the wrinkles about until they entirely disappear. Many starchers, preliminary to this, lay the collars or cuffs on the table one over the other, with a layer of starch between each, and give the dozen a wringing or twisting motion, in the belief that it facilitates the penetration of the starch in the subsequent rubbing. If shirts are being starched, a dozen or more are rubbed on the wrong side, then finished on the right; if collars or cuffs, they are piled up until several dozen have accumulated, when the "wiping off" takes place.—*Troy Laundry Journal.*

LANTERN TRANSPARENCIES ON WET COLLODION.*

THE reports of the meetings of the photographic societies have, during the past year or two, indicated an increasing interest on the part of amateurs in the making of transparencies for the lantern, and the subject certainly merits the attention of all enthusiastic workers. There is no more fascinating branch of our art than the making of these little pictures, and good work cannot be shown in a more effective way.

Gelatine, which is now such an important item in all branches of photography, has been adapted to the use of slide makers in the form of gelatino-chloride plates, and more recently in the shape of special bromide plates. But it appears to be the opinion of most experienced workers that it cannot compete with collodion for this particular purpose. There is a brilliancy and delicacy about collodion transparencies that cannot be equaled by gelatine, at least so far as I have seen. There is, I believe, a new gelatine plate, and a new developer therefor, which are said to give results which run collodion very close. But I have not seen any slides made on these plates. Doubtless they will be brought under your notice at an early meeting.

Last winter I showed you the process of making dry collodion plates, and I think you must admit that the process is not difficult. Still, I can understand that some of you, who dislike messing about with unfamiliar chemicals, would rather stick to ready made gelatino-chloride plates for contact work. To-night, however, I am going to speak about camera printing, which is much the better way of making slides, for it enables you to use as much or as little of your negative as you may think fit. Now, for this purpose, collodion is much too slow, and gelatino-chloride is quite out of the question. Indeed, I have seen it stated that the latter is 30,000 times slower than an ordinary plate for negative work, and that on the authority of Mr. Cowan, who introduced these plates.

We are, therefore, introduced to either gelatino-bromide or wet collodion, and the latter is much to be preferred, on account of the manifest superiority of the result. It is a fact worth noting, that professional slide makers use it, which would hardly be the case if they knew a better process. It is also a strong argument in its favor that a negative which is rather too dense or too thin can be made to yield a good slide, where gelatine would lead to hopeless failure. Then as regards cost, collodion is more economical than gelatine. Gelatino-chloride plates cost, say, 1s. 6d. per dozen, and he will be a very clever worker who gets twelve good slides out of the dozen. Every plate spoiled is dead loss, and the developer is expensive. On the other hand, wet collodion slides can be coated, sensitized, and developed for about 1s. a dozen, including cost of glass, and allowing for a good proportion of failure. Spoiled plates are, of course, simply washed off, and the glass used over again.

It has been objected that the use of the silver bath leads to black fingers. Well, that depends on the worker. I have known some men get their hands in an awful state (and their linen too) over the development of two or three gelatine plates with pyro-ammonia, but in my experience it is quite easy to work small plates in the bath and find only a brown streak across one finger and thumb, which a bit of pumice-stone will remove in a few seconds.

Now, having discussed the merits of the process, let us pass on to practical details. First, as regards apparatus. Here is a plank of such length that when one end rests on the window sill, and the other on the floor, it will point to the sky, clear of chimneys, etc. On this board are nailed two runners, between which the camera can slide backward and forward. Across one end is a little platform with a raised ledge at right angles to the runners, and on this rests a box to carry the negative; the said box sliding against the ledge, and being raised by the platform, so that the center of the negative is opposite the lens when the camera is in its place. The camera may be your ordinary outdoor one, but it is better to have a quarter plate wooden camera of the old fashioned, wet plate style; or, better still, to make one out of old material, as I have done. It is not elegant, but serves the purpose. I recommend a special camera because it is in every way best to work by daylight. Now, few of us have much leisure by day, and it is advisable to have a camera that you can leave always in place, and focused ready for work, thus leaving more time for making slides. However, should you prefer to use your every-day camera, it will be necessary to make a corner for the small plates, which should be built up of glass strips, with corner pieces cemented on with marine glue. Wooden carriers will, sooner or later, give foggy plates, and cause bad language in the dark room.

The box for holding the negative should have a hole cut in the bottom just the size of the negative, and both box and camera should be well blackened inside. Lampblack stirred up in a strong solution of gelatine is the handiest thing to use, and it is a capital thing for filling up leaks and making things light-tight.

The camera, if home made, should have sufficient extension to admit of slightly enlarging part of a negative. The actual length will, of course, depend on the focal length of the lens used.

The dark slide may be either a special wet plate slide or an ordinary double dark cell. I use a quarter plate double slide, having glass corner pieces cemented into the deepest half; but if you use a larger slide, then the glass carrier already mentioned will be required.

The lens should be of the rectilinear type, but a single lens *may* be used if nothing better is available. It should be of short focus, if possible, and probably the very best lens for the purpose would be a portable symmetrical, on account of its covering power. I use an eight and a half inch rectilinear, which works well with stop $\frac{f}{16}$, but if I had a shorter one I would use it.

For focusing I put the dark slide in place, and insert a collodion plate, sensitized, washed, and dried. A finer surface would be difficult to find, and accurate focusing is easy on such a film; ground glass is much too coarse. This film being actually the same as the plate about to be exposed, and being in the actual dark slide, perfect register is a certainty.

Having thus briefly described the apparatus, I shall now show you how to use it.

First of all, however, I should like to speak about the light to be used. For sake of demonstration I am going to use magnesium ribbon to-night, but if the best results are to be obtained, good daylight should be used. For ordinary negatives diffused light is best, but if the negative is dense, then direct sunlight should be used, ground glass being placed between the sun and the negative to insure even illumination. For a weak negative, diffused light, with ground glass, will give the best result.

Now I take the baseboard and place it on the table, and having fixed the negative in its place on the bottom of the box, I lay the box on the platform, close up to the ledge. Then, putting the camera in place between the runners, slide it backward and forward till I get the required amount of the picture on the focusing screen and clamp it. Then placing a light board along the top of the camera and negative box, I cover the intervening space with the focusing cloth. Now, using the focusing screen and a magnifying glass, I proceed to get the greatest possible sharpness.

When working by artificial light the negative may be illuminated by turning the lantern on it, or by placing a paraffine lamp close to it, in either case putting a sheet of ground glass behind the negative to diffuse the light. It must be distinctly understood, however, that I do not recommend artificial light, and I am merely about to use it in order to show you the process of working wet plates.

Everything is now ready except the plate, and I shall proceed to say something about the chemical part of the process while getting it ready.

The glass should be good, and as free from specks and flaws as possible. When new it should be rubbed on both sides with weak hydrochloric acid, rinsed in water, and set up to dry. Then, the evening before it is wanted, it should be rubbed with tripoli and spirit of wine, or, better still, with a drop of old iodized collodion, then polished off with a clean cloth, and finally with a piece of clean chamois leather. The plate thus cleaned should be kept free from dust. The final polishing with leather should not be done immediately before using, or the glass, being electrified, will not hold the film, and you may see a choice slide or two disappear down the sink.

The collodion may be ordinary iodized negative, but it is better to add to each ounce, a day or so before beginning to use it, two grains of cadmium bromide. This causes it to give a film more sensitive to faint light, and thus secures more delicacy and detail in the lights of the slide. It should not be newly iodized, but is best when about three months old. The date of iodizing may be found on the bottle when buying it.

I now pour some of this collodion on to a plate, and by tilting the glass cause it to flow over the whole surface; then, while pouring off the surplus, rock the plate about to insure even setting, free from lines. The surplus collodion should be poured into a small funnel having a plug of cotton wool in its neck, and allowed to filter through into a second bottle, thus getting rid of any dust which it may have washed off the plate. When set I place it on the dipper, and lower it steadily, without stoppage and without hurry, into the silver bath, where we will leave it while we turn our attention to the other chemicals. When the collodion contains a considerable proportion of bromide, as I have recommended, the plate should remain not less than two minutes in the bath, because no bromide of silver will be formed till the iodide is saturated. My own practice is to leave the plate in the bath while I expose and develop the previous one, and it does not seem to suffer by such long immersion.

My dipping bath consists of a No. 7 flat battery cell, thoroughly saturated, while hot, with paraffine, and it serves the purpose admirably. The dipper is a strip of glass one inch broad, having a narrow strip cemented across the bottom with marine glue to support the plate.

The silver solution, or "bath," as it is called, is the only thing that may prove troublesome. It consists of a thirty-grain solution of silver nitrate, and a little care in making this up may save many failures. The silver nitrate is dissolved in about one-fourth of the water, and to this is added a grain of potassium iodide dissolved in a few drops of water. The reason for this is that the silver solution dissolves a small amount of silver iodide, and would therefore attack the first plate sensitized. The rest of the water is then added, when some of the silver iodide will be precipitated, leaving the solution fully saturated. A solution of sodium carbonate should now be added till a precipitate of silver carbonate begins to form, and the bath, being thus neutralized, should be exposed to daylight—or, better still, sunlight—for a day or two. Organic impurities in the water will thus be thrown down as a brown precipitate, leaving the silver solution pure. Sufficient solution should be prepared to fill the dipping bath at least twice over, and after "sunning" half the quantity, should be decanted, or filtered off, and acidified with dilute nitric acid till it just reddens litmus paper after thirty seconds' immersion, and it is now ready for use.

After a time symptoms of fog will be found in the plates, and this is a warning to change the bath. The second half of the original solution is now to be acidified and taken into use, while the first half is poured into the bottle, neutralized, and placed in sunlight till required, at the same time adding, say, fifteen grains of silver nitrate to replace that taken up by the plates.

By and by a new trouble will arise. A yellow deposit will be found on the dipper, and the plates, after fixing, will be full of minute pin holes. This denotes that the bath is over-saturated with iodide of silver. By this time, however, the quantity will have been reduced by use, and if water be added to make up the original bulk the iodide will be thrown down as a precipitate, which should be filtered out, and then silver nitrate added to make up the original strength. If the bath absorbs so much alcohol and ether from the collodion that the developer will not flow easily, it should be exposed in a flat tray instead of the glass bottle, when the spirit will evaporate.

These operations doubtless sound very elaborate, but it must be remembered that they are only necessary at considerable intervals, and that a large number of slides may be made before the bath needs any attention. Every precaution must of course be taken to keep unnecessary impurities out of the bath—especially hypo and developer.

The plate which I placed in the bath will now be fully sensitized, and I remove it and rear it up on clean blotting paper to drain, while I coat and immerse another. Now I take the drained plate, and after wiping the back with a piece of blotting paper, place it in the dark slide.

I need hardly say that we are supposed to be in the dark room, though I am working by gas light just now so that you may all see what I am about.

I now put the slide in place in the camera and draw the shutter, and then proceed to burn about eighteen inches of magnesium ribbon behind the negative, which is covered with ground glass. The ribbon is moved about to insure even illumination. The slide now being closed, we are ready to think about development.

The developer is a solution of iron protosulphate (ferrous sulphate) acidified with acetic acid. The iron should be clean and of the characteristic pale green color; if rusty, it should be washed till clean and the crystals dried on blotting paper.

A good average developer consists of—

Ferrous sulphate	30 grains.
Glacial acetic acid	20 minims.
Water	1 ounce.

I add a little sugar, gelatine, etc., to secure a warm tone, but this necessitates a longer exposure, as it gives a tendency to hardness. If nothing of this kind is added, then a little alcohol is necessary to make the developer flow easily.

By varying the strength of the developer, equally good results may be got from thin or dense negatives, and this is one of the merits of the wet plate process.

In dry plates the image is formed in a thickish film, from silver already there; and if we expose a dense negative a long time to secure detail in the lights, the action goes on in the shadows right through the film, and no variation in the strength of the developer can quite prevent the "blocking up" which naturally results. If the negative is very thin, a very short exposure is necessary, and the very slight impact of light does not seem to be sufficient to give vigorous shadows, unless with very skillful development, and the slide at best generally suffers in tone. (This remark refers to camera printing with bromide plates; chloride plates, by contact, frequently give good slides from weak negatives.)

Wet plates are altogether different; the silver *in* the film is little, if at all, reduced by the developer, and the "blocking up" by prolonged exposure does not occur if the developer is strong enough.

The wet plate developer mixes with the nitrate solution on the plate, and throws down a precipitate of silver on the latent image. This precipitation takes place more or less rapidly, according to the greater or less strength of the iron solution of acid present. A strong developer showers down the silver on shadow and half tone alike, and if too strong, deposits it all over the plate independently of the image. A weak developer precipitates the silver so slowly that it is nearly all attracted to the shadows, thus giving great contrast, and in both cases the tone is much the same. A long exposure does not materially increase the attractive power of the shadows, while it allows the detail of the lighter half tones to be impressed, in the case of a dense negative, and the use of a strong developer still further decreases the contrast. When a weak negative is in question, a slight exposure gives the shadows a slight advantage, which is increased by the use of a weak developer. From ten to fifty grains of iron may be used, the acid remaining the same.

I now take the exposed plate on a pneumatic holder, and measuring out just sufficient developer to cover the plate, I pour it quickly on, causing it to work round and round to insure even development. Care should be taken not to allow any developer to fall off the plate, as it would carry with it some of the silver necessary to form the image; should the contrasts

* A communication to the Glasgow and West of Scotland Amateur Photographic Association.

in the negative be *very* strong, however, a little silver may be allowed to wash off.

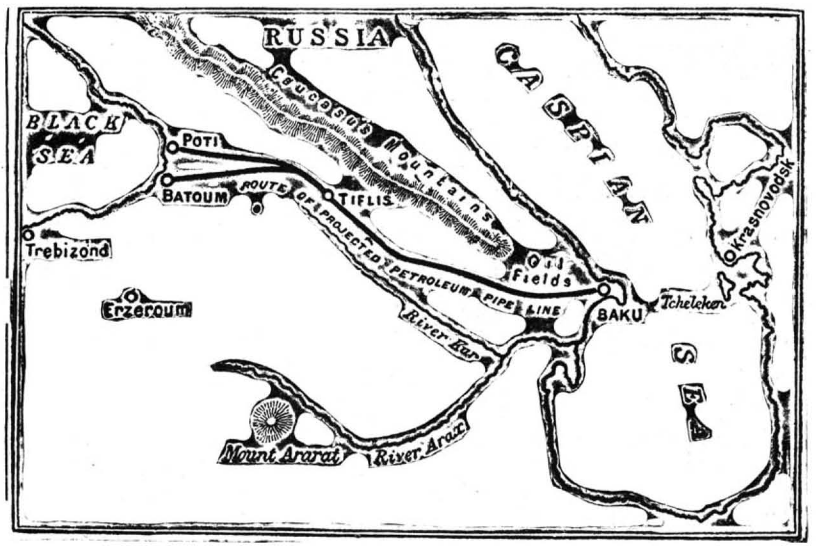
Development is rapid, and as soon as sufficient density is obtained I wash off the developer under a stream of water, and fix in hypo. When fixed, a few minutes' washing under the tap will suffice, and the slide may be dried and varnished with filtered varnish.

Full density should be obtained if possible by development, but if intensification is necessary a drachm of developer and a drachm of fifteen grain solution of gelatine are mixed, and a few drops of the silver bath added. This is flowed over the plate till density is attained. Intensify before fixing if the slide is under exposed, and after fixing if fully or over exposed. The gelatine prevents injury to the tone.—*W. Goodwin in Br. Jour. of Photo.*

A LONG PIPE.

WE have received a copy of "The Coming Deluge of Russian Petroleum," by Mr. Charles Marvin, who may now be considered an authority on the regions of eternal fire. This topic is creating considerable attention just now, and as Mr. Marvin describes the mammoth oil fountains of Baku we are inclined to think with him that "the Americans are no longer in it." The author points out that 16 gallons of oil may be had for a penny, and that Russia has invested £1,000,000 in oil steamers to carry it in tanks to the English market. The quality of the oil is undoubted, and large consignments have for years been sent to England to Sir Charles Price & Co.

But the facts narrated in Mr. Marvin's pamphlet only interest our readers, inasmuch as it is proposed to lay a pipe 600 miles long. The author declares that a leading English firm like Messrs. John Russell & Co., of Walsall and Wednesbury, who were intrusted by the British Government with the task of supplying the pipes for the Suakim-Berber water pipe line, can manufacture two miles of pipe per day, and could easily provide the whole line within the required time. In a recent number of the *Pall Mall Gazette*, Mr. Marvin discussed the whole question which forms the subject matter of his pamphlet. He remarked that as the Russian Government had completed the scheme for the petroleum pipe line from Baku to the Black Sea, and was willing that two-thirds of the pipe line, or four hundred miles of iron pipes, should be constructed by the country



PLAN OF PROJECTED PIPE LINE FROM BAKU TO THE BLACK SEA

acquiring the concession, the possibility of securing such a great and lucrative order should direct the attention of England to the enterprise. He adds: "Already four foreign competitors are in the field, among them being the Paris Rothschilds and a Belgian firm, supported by a group of bankers; but the Russian Government is anxious to secure "the lowest tender." The capital required for the scheme is £2,000,000, and the undertaking therefore would need a powerful syndicate to carry it out. If we do not construct the pipe line, Germany, Belgium, or France almost certainly will. For at least the last ten years there has been talk of laying down a pipe line from the oil fields at Baku to some point on the Black Sea. The original obstacle to the scheme was the undeveloped condition of the industry, and the advocacy of the undertaking by mere concession mongers; and afterward the completion of the railway from Baku to Batoum put a temporary extinguisher on all projects presented to the government. The interest on the capital of this railway being guaranteed by the state, the reasons dictating such a policy can be readily appreciated.

Last year, however, the traffic on the line, although only two years old, was already too large for its resources, and the government decided upon the construction of an oleoduct. Excluding Nobel Brothers, there were no rich firms to provide the necessary capital, and the government was compelled to consent to the concession being placed in foreign hands. The line must start from Baku, but the terminal point on the Black Sea is left open for the present. In all probability Poti, and not Batoum, will be insisted upon. The projected route is shown in the accompanying sketch map.

The pipe must be large enough to allow of the passage of 160,000,000 gallons of oil a year, and the stoppages for repairs must not exceed on an average one a month, or last longer than three days. As soon as the traffic reaches 90 per cent. of the full working power of the line, the company must proceed to lay down a second oleoduct, and have it ready for traffic in two years. The time allowed for laying down the first pipe line is three years. The concession will last twenty years, but no guarantee will be given by the state, nor will the company be allowed to own oil wells and refineries. The engineering obstacles to the enterprise are of a very trifling charater, with the exception of the passage of the pipe line over the Lesser Caucasus.

The ascent to the Suram Pass, 3,200 feet above the sea level, is somewhat sharp, but an extra number of powerful pumping stations will overcome this obstacle, while on the Batoum side of the range fewer stations will be needed, owing to the force with which the oil will flow, by its own gravity, to the Black Sea coast. As for the distance, it is a mere trifle compared with the American pipe lines, which collectively extend to a length of 9,000 miles. At present tens of millions of gallons of refined petroleum can be had at Baku for a penny a gallon. The projected pipe line will run it across to the Black Sea for another halfpenny, and for very little more than that sum it will be possible to bring it to London in tank steamers.

Another interesting contribution to the history of the petrolem fields and trade of Southeastern Russia has been made by Colonel C. E. Stewart, C.B., who lately returned from a visit to the producing districts. Colonel Stewart believes that petroleum will be found widely in Afghanistan and Beloochistan, when these countries have been better explored; and the existence of mud volcanoes on the shores of the Persian Gulf points, he thinks, to the presence of petroleum in that neighborhood. Colonel Stewart thinks that a great opening will occur for English merchants as soon as the pipe line is laid down from Baku to Batoum or Poti for commencing a profitable business, by erecting storage tanks at Batoum and purchasing oil and other petroleum products from the refiners; but he does not consider that it will ever pay an English firm to own wells or refine oil at Baku. There are already too many refineries there, and the business requires to be moved to the Black Sea coast if it is to flourish. But in the Caucasus, besides petroleum, there are many other products which it would pay to export—boxwood, oak, Indian corn, silver lead ore, manganese, and perhaps copper. He therefore recommends that English firms should send out their own agents to make inquiries on the spot. The journey is not an expensive one, and the country is full of German agents, who are ready to take advantage of the opportunity when the pipe line is opened, and if British traders are not early in the field, they will find themselves shut out from this trade.—*Gas Engineer.*

EXPERIMENTAL BALLOONING.*

By FRED. W. BREAREY.

THE society which I have the honor to represent has never advocated the employment of the balloon as a means of aerial locomotion for every-day purposes of transit. It is on record under what circumstances we value it, but ignore it as an auxiliary to mechanical efforts. We are passing through a period of excitement and extravagant expectation, the outcome of a few experiments with balloons conducted under favorable circumstances. The periodicals, scientific and otherwise, have accustomed us to a repetition of the experiments of those few French inventors who have been able, through the liberality of their government, to put into practice their notions of the requirements of aerial navagation, viz., levitation as against gravitation. The newspapers in England have apparently confined their reports to experiments conducted in France by French aeronauts with French money. They have quite disregarded those equally successful attempts made in France by a late member of this society with the aid of English money prior to the Meudon experiments. The name of that member was Mr. Frederick A. Gower, who lately was cast away in a balloon, the particulars of which can never be recorded, as no trace of him has been discovered. I am able to give extracts, however, from a memorandum forwarded on the 14th June, 1883, to Prof. Tyndall, at the Royal Institution, by Mr. Gower, as follows: "A series of experiments which have been carried on in the neighborhood of Paris for the past two years yielded results this afternoon which seem to me worthy of general attention, from the fact of their having included the driving of a large balloon fairly against the wind by steam power. The aerostat in question consists of an envelope of gold beater's skin in the form of a cylinder, with rounded ends, and flattened somewhat at the sides. Its length is 30 meters, and diameter 10 meters, with a capacity, say, of 2,000 cubic meters, and a lifting power when filled with hydrogen of something over two tons. A car of wickerwork, fortified with brass tubes along its length beneath, is suspended by netting in the usual manner for nearly the whole length of the balloon. At or near the central point of this car is placed a double cylinder horizontal engine of 5 horse power, made al most wholly of bronze. From this extends a shaft of steel tubing 1¼ in. in diameter, and provided with knees to allow of slight deflections, straight to the forward end of the car, where it is geared to a nearly upright shaft of larger size, which serves to supply the power to an upright flywheel, or fan, about 1½ meters in diameter, placed exactly upon the line of the center of the aerostat, at a right angle to its length and about 6 in. from the envelope. The blades of this wheel are of wood, one centimeter in thickness, and having an area of about 0·19 of a square meter each. They are quite flat, and set perpendicularly to their axis, which is itself as nearly horizontal as possible. The wheel is not, therefore, designed to have any propelling power as a screw, and is apparently capable of no function other than that of rarefying the air in its vicinity when turned at a high rate of speed." Here follows a detailed account of what Mr. Gower considers a successful experiment. This I omit. But I cannot avoid noticing a significant paragraph in this memorandum. He writes: "A very gentle breeze was blowing from the north, and the machine was held by the forward end (that of the fan wheel), in order that the stern might swing exactly into the line of the wind's direction. The engine was then started upon the same conditions of speed as before, and the balloon was released, *except that a man at each end walked by the car with small bags of sand, which he hung upon the car, or removed, as the slight changes in equilibrium demanded.* The machine yielded a foot or two to the slight airs, then gathered headway and moved forward directly in the 'eye of the wind,' which was blowing at from three to four kilometers the hour." It must be understood that I have emphasized, as far as italics will allow me, all that is said about the means taken for preserving the equilibrium of this balloon, whose length is 30 meters to 10 meters diameter. The significance of these italics will be strengthened by what I shall have further occasion to observe. The *Morning News*, till lately published in Paris, says: "The successful experiment by Mr. Gower was made on June 14, 1883, and was witnessed by a large number of people, who have attested its success. There can be no question that, notwithstanding Frenchmen have done much in the way of invention toward this achievement, it was an American, aided in part by English capital, who first constructed and drove against the wind a large balloon, and this more than a year before the experiments at Meudon." At a lecture delivered at the United Service Institution by Mr. Gower, shortly before his balloon fatality, I asked him how he maintained the shape of his balloon, seeing that it was upon its shape that he so much depended for success. He replied that there was no other stiffening but that which arose from distention by the gas. I remarked that the shape was likely to be altered by the act of propulsion against the atmosphere, and consequent compression of the gas. This he admitted. It follows, therefore, from this absence of rigidity, that the rate of progress through the air must be limited by the ability of the envelope to sustain the pressure of the compressed gas. An analogy has been attempted to be drawn between the balloon and the fish. Undoubtedly the fish can swim against a strong current; but consider the difference in the structure of the two. The body of the fish is homogeneous throughout; whereas the only substance of the balloon is that which is comprised in its thin envelope. Upon this absence of rigidity General Hutchinson comments in his article upon "Navigable Balloons," inserted in the *Broad Arrow*, Sept. 12, 1885. He quotes Gaston Tissandier, whose pamphlet advocates extreme lengths, up to 1,000 yards even, and who hopes, he says, to attain "the speed of express trains, and command over nearly every wind." In fact, we are having over again the extravagant speculations of the first experimenters and writers in aeronautics. In the conclusion of his article, General Hutchinson, who is a great advocate for extension of length, naively remarks: "Another question is, how best to impart the requisite stiffness to the envelope, and such a constantly preserved automatic pressure as will keep it (with its embracing net), when only partially filled with gas, *constantly* stretched under all conditions of altitude and temperature." Yes, I think the General will find the attainment of those conditions a poser; for let us see what shaped gas envelope is recommended, viz., a cylindrical form "as the best of forms," and "because," it is said, "the less its diameter, the less the bursting strain;" and also that "it is the simplest form to construct when made of prepared silk—merely breadth of the material joined at the selvage." Therefore, we are free to imagine, simply as a model (because the proportions would be much greater), a sausage the length of this room, and about 3 ft. thick, with both ends cut off, and two extinguishers substituted. But the outer skin of this sausage is its only substance. Its gaseous interior is subject to uncertain vagaries, depending upon temperature and pressure. As well attempt to propel a spirit level with the air bubble maintained in the center as propel such an apparatus against a wind. And this observation is apropos of my italics. To stiffen such an apparatus so as to make it effective would add too much weight, so that this aerial sausage might just as well be stuffed with pork. Yet the most difficult problem of all is left to the last, as one of the minor details. Alluding to Mr. Gower, and the loss of himself and balloon at sea, one is led to reflect upon the many narrow escapes from death which have occurred to aeronauts within sight of land, and their apparent helplessness under such conditions. Now it appears to me that there has been a want of mechanical devices to meet exigencies of this nature. It is evident that when an accident of this kind occurs, it is seldom through a catastrophe, such as a rupture, but nearly always through condensation of the gas, and the descent into the sea is gradual. The weight carried and the balloon are nearly in equilibrium, the man being a little heavier. Now these are the conditions which I should like to see carried out in a small experimental balloon without a valve, car, or ballast, the aeronaut sitting saddlewise armed with a punting pole shod with a termination fitted to push off from the surface of water, trees, houses, and land. The punter in a tideway keeps himself from shore under the influence of the stream with a pole. Is it not feasible that the aeronaut so equipped could keep his balloon under the influence of the aerial tide by pushing from whatever may be underneath him? A push of 40 lb. would be equivalent to nearly 1,000 ft. of gas added to his balloon; therefore, I think many a ducking would have been saved by the simple provision of a suitably shod pole suspended from the car ready for use. A pole shod with a circular disk, the upper portion of which sloped upward, would be hardly suitable in this case.

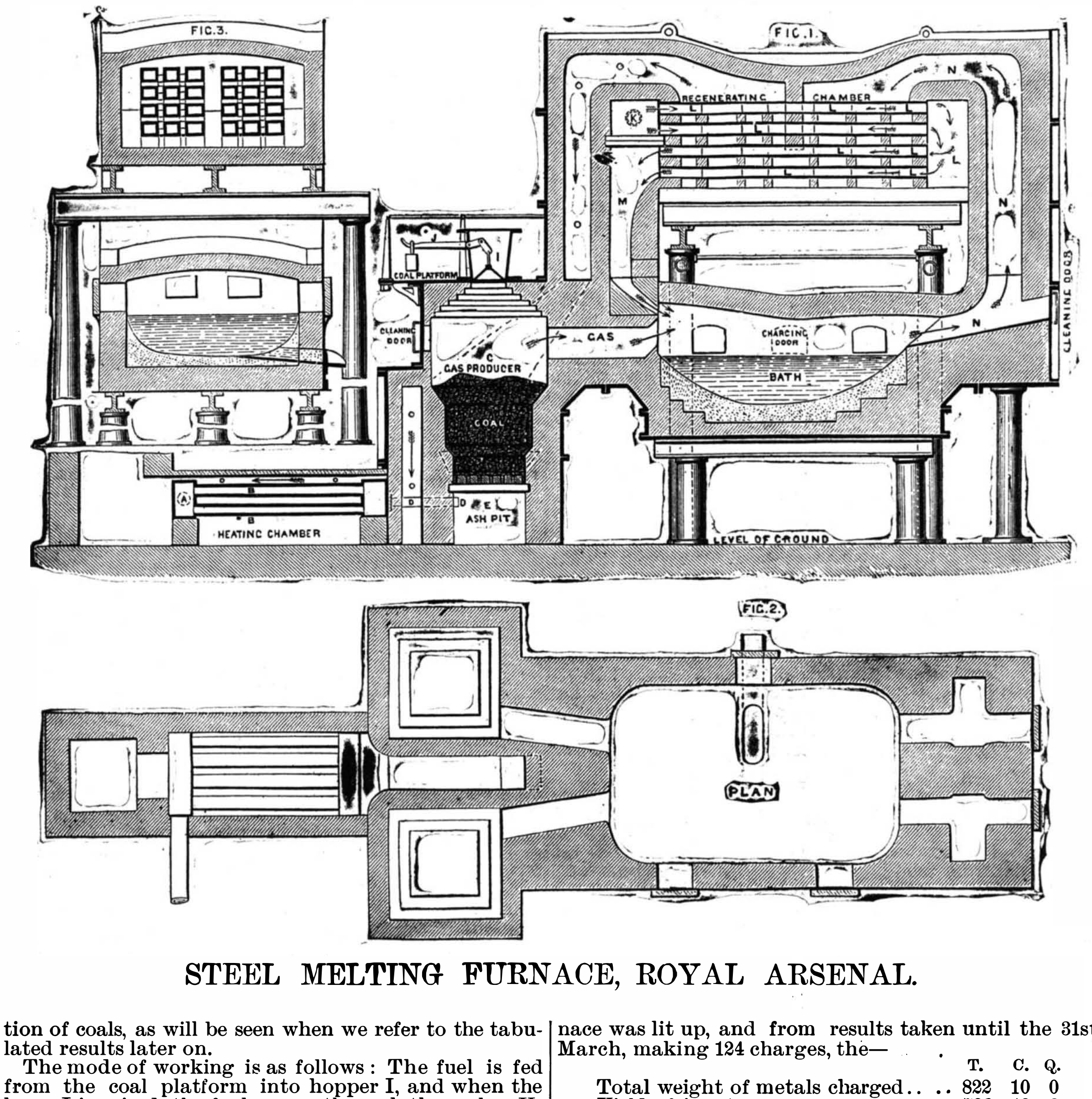
* Read before the Aeronautical Society, London, December 11, 1886.

TO make gum tolu ready for chewing, take of balsam tolu four parts and of gum benzoin, white wax, paraffin, and powdered sugar, one part each. Melt together, mix well, and roll into sticks.

THE RADCLIFFE STEEL FURNACE.

WE furnish below an engraving of the Radcliffe furnace, three of which are at present working at the Royal Arsenal, Woolwich. We also give a tabulated list of the actual quantities of steel produced in a given time, the amount of coals required per ton of steel, and the amount of loss or waste also. The operations extend in all over a period of eighteen months, and as every pound of steel produced and coal consumed has been weighed in the ordinary manner, these results may be taken as absolutely correct. Referring to the illustration, it will be seen, says *The Engineer*, that this furnace is built entirely above the level of the floor, the bath and regenerator being supported upon wrought iron girders, resting upon cast iron columns carried down to the ground level. The furnace is composed of a gas producer, bath or reverberating chamber, regenerating chamber, and air heating apparatus.

The accompanying Figs. 1, 2, 3, represent a furnace constructed upon this principle for the manufacture of open hearth steel. Fig. 1 is a vertical section through the combustion chamber, regenerator, and gas producers; Fig. 2 is a horizontal section through the line A B of Fig. 1, looking down on the combustion chamber; Fig. 3 is a cross section through generator and bath. The leading advantages of this furnace are: First, simplicity of construction, there being no portion under ground, and every part is easily got at for repairs. Secondly, economy of space; the gas producer being a portion of the furnace, no independent and expensive gas plant is required. Thirdly, the current being continuous in one direction only, complicated and troublesome arrangements for reversing have been avoided. Fourthly, greater economy in the consumption of coals, as will be seen when we refer to the tabulated results later on.



STEEL MELTING FURNACE, ROYAL ARSENAL.

and straining of the supporting ironwork. It is found preferable to use a forced air supply for the pressure in the gas producers, 6 in. of water being sufficient, and for the regenerator a pressure of 3 in. being ample. Before the air supply is allowed to pass into the gas producers, it is heated to a temperature of between 700 deg. and 900 deg. Fah., and according as the air is expanded by heat, a less weight of it will effect the work of releasing the gas from the fuel; then it must necessarily follow that the gas produced will be richer in heating qualities, in consequence of such a minimum volume of nitrogen being allowed to enter the producers.

Again, gas produced under such conditions is of such a high temperature that it needs no regeneration, and is passed immediately into the combustion or melting chamber. The temperature in the gas producers is too high for the heavy hydrocarbons to be produced in the form of tar, pitch, etc., the latter being functions of low temperature gas producers accompanied with slow distillation. Hence it follows that in producers where the heat is too great to allow the tarry products to form and be deposited, the resulting gas must be richer in heating qualities accordingly.

From the producers now in general use the gas is generated at a low temperature, because of the air supply being sent cold into the midst of the fuel, and the gas produced from the excessive supply of air contains a great volume of nitrogen. An old furnace was altered in the Royal Gun Factories about eighteen months ago, with a view to practically proving this principle. This furnace is of six tons capacity, and in due time set to work with the following results, the average consumption of fuel being 8·5 cwt. per ton of ingot produced. On January 9, 1886, after a repair, the furnace was lit up, and from results taken until the 31st March, making 124 charges, the—

	T.	C.	Q.
Total weight of metals charged.. ..	822	10	0
Yield of ingots..........................	786	12	3
Loss as skulls and other scrap...4·3%			
Fuel consumed..........................	339·	6	0

The fuel includes eleven tons used in heating the furnace preparatory to the first charge. A ten ton furnace—built to replace an old furnace to economize space, so as to give room for an additional reheating furnace to one of the hammers—commenced work on the 18th June, for the week ending June 26:

	T.	C.	Q.
Weight of metals charged...	101	10	0
Yield of ingots.........................	96	15	0
Weight of skulls and scrap.........	1	13	2
Weight of fuel.........................	29	5	0

Being equal to 6·04 cwt. per ton of ingot.

Then, again, for the week ending July 3—holiday on the Monday for Coronation Day, and the furnace had to be kept going without a charge in it from Saturday noon until Tuesday morning, when it was charged:

	T.	C.	Q.
Weight of metals charged	78	10	0
Yield of ingots.........................	75	6	3
Weight of skulls and scrap.........	1	0	3
Weight of fuel consumed............	24	0	0

Being equal to 6·37 cwt. per ton of ingot.

For the week ending July 10:

	T.	C.	Q.
Weight of metals charged...........	96	5	0
Yield of ingots.........................	91	9	3
Weight of skulls and scrap.........	1	16	1
Weight of fuel consumed............	26	17	0

Being equal to 5·87 cwt. per ton of ingot.

We wish it to be distinctly understood that the fuel herein given includes what is burnt between Saturdays and Mondays, to keep the furnace going, and the fuel and other materials of the charges is all weighed by the store department, the latter being quite independent of the forge branch. It is found also that in the ten ton furnace, constructed to carry out the idea in a more complete way than was done in the experimental six ton furnace, no more coal is consumed in the larger than was consumed in the smaller furnace. Further experience in the work and design of these furnaces has confirmed the results already given above, and leads to expectations of further economy in working when the larger furnace of 20 tons, which is being erected, is completed.

The mode of working is as follows: The fuel is fed from the coal platform into hopper I, and when the lever J is raised, the fuel passes through the valve H, into the gas producer G. The air for causing the combustion of the fuel in the gas producer is delivered from a blower under pressure, and enters the air heating chamber at the inlet A, which is a junction box carrying the end of the heating tubes B, through which the air is passed into a second junction box, to which the heating tubes are connected by expansion joints. The pipe D is fixed at one end to the second junction box, and conducts the heated air from the heating apparatus to the ashpit E of the gas producer from below, and having caused the combustion of the fuel, the gases pass on to meet the air for its combustion from the regenerator. The air used in conjunction with the gas enters the regenerator at the point K, and is under pressure. It then passes through regenerator tubes L in the direction shown by the arrows, and passes through the flue M to meet the gas from the gas producer, as before mentioned. The waste gas after having done duty in the bath passes through the flue N into the regenerating chamber, and in its passage gives out a portion of its heat for the purpose of heating the air that passes through the regenerator tubes. It then passes through the flues O O, partly behind the gas producer, and shown by dotted lines, to the air heating chamber, where it gives out a remaining portion of heat for the purpose of heating the air passing through the wrought iron tubes to the gas producer, by the pipe D. The whole furnace, including the gas producer, regenerator, and combustion chamber, is combined in one structure, and incased in plates bolted together at the flanges, and is strengthened further by strong tie bolts passing through from one side to the other, and fixed with cotters and nuts.

When a new furnace is ready for lighting, it is treated in the usual way by careful and gradual firing to avoid the evils of sudden expansion of the brickwork

SOUTH BOSTON STEEL WORKS.

THERE has been in operation in South Boston since last April an open hearth steel furnace for the production of boiler plate, embracing tank, shell, flange, and fire box plate. The new mill, which is known as the Bay State Steel Works, is situated on East Fourth Street, and occupies the old steel mill building of the Bay State Iron Company, which once produced open hearth steel, but whose furnace was abandoned some years ago. The old furnace was a Siemens-Martin, as is the present, which has a capacity of 5 gross tons and is an improved design, the improvements consisting mainly in small details which have been noted from time to time. The furnace is run night and day, turning out four heats of five gross tons each, making the total production twenty gross tons per day.

The quality of steel turned out depends upon the use to which it is to be put. The four qualities of boiler plate are manufactured, and, while the bulk of the product is used for boiler purposes, there is some of it used for tanks, penstocks, etc. The quality of the best grade of steel made here is said to be equal to any on the market or to the best grade of the old Benzon steel, so popular with boiler makers in New England. The raw material for this steel is the English West Coast hematite, which is cheaper and in some ways, it is said, better than American pig iron; northern New York charcoal blooms, which is excellent material, and scrap steel.

PETROLEUM GAS.

The ingots are cast in cast iron moulds. They range in weight from about 3,500 lb. to 1,500 lb. Some are five feet long, twenty-six inches wide, and nine inches thick, and others are four feet long, twenty-four inches wide, and seven inches thick. The fuel used in the furnace is not the usual coal or coal gas, but is petroleum gas, which is made and fed into the furnace by an invention of Mr. George W. Gogin, the superintendent of the mill. The petroleum is kept in a tank in the yard, and is brought in by a small Worthington pump through a two-inch pipe into a generator, so called, which is made of iron or steel plates, and is six feet high and four feet wide. Here it passes through a series of eight 2 inch pipes, which are exposed to a strong heat, and then runs into a small iron bulb or atomizer, so called. Here it meets a stream of superheated steam, which has come from some of the boilers about the mill, and then goes through a five inch pipe to the generator, where it passes through a series of four 5 inch pipes, where it is superheated.

When the steam strikes the hot petroleum, it volatilizes or vaporizes it. A small tube from the atomizer runs down to the bottom of the generator, and this pipe furnishes the fuel for heating the generator, or the different pipes in which the fluid petroleum and the steam are passing. The generator is practically automatic in its workings, as it is merely necessary to light the gas at the outlet, the degree of heat being regulated by the amount of gas let on by the cock in the pipe. There is a necessary arrangement for burning the semi-fluid and semi-gaseous petroleum, which comes out for the first twenty minutes after the light is applied or until sufficient heat is generated to form the gas perfectly. After this is lighted the generator is practically automatic in its workings, and can be left to itself, with an occasional look to the cocks which regulate the flow of gas or to the pump which regulates the flow of the petroleum. The pump is run by steam.

ADVANTAGES OF THE GAS FURNACE.

The vapor or gaseous petroleum flows into the furnace through a two inch pipe, the flow being regulated by a valve and cock. The amount of heat furnished in the boiler depends upon the amount of gas which is let into it. The great advantages of this gas generator and of this petroleum fuel are the simplicity of arrangement and use, the economy of space, and great cleanliness. The size of the generator, six feet by four, and the small space occupied by the little pump, shows the great economy of space, particularly when it is considered that it can furnish double the gas required to run a five ton furnace. The simplicity of arrangement and use has been seen from the description of the apparatus, and the much greater cleanliness than there is with the use of coal may be readily seen.

It is not claimed for this petroleum fuel that it is at present cheaper than coal or coal gas fuel.

At the present price of petroleum the cost of this fuel is practically the same as the cost of the coal or coal gas at the furnaces. It is very probable, however, that the cost will be brought down to a lower point than the cost of gas. Even if this result cannot be reached, the other features will commend it for general use, provided the cost be practically the same as coal gas. The plant at South Boston is the only one which is using this form of a petroleum gas furnace.

ROLLING.

The steel mill is 150x60 feet, and from this mill the ingots are carried to the rolling mill of the Bay State Iron Company, which is about 200x200 feet, and is directly behind the steel mill. This rolling mill is the latest one built, and is provided with two sets of rolls, one a two-high set, about 108 inches long, and the other a three-high set, and about 84 inches long. The rolls are of chilled cast iron, and the process of rolling does not differ materially from other forms of iron rolling, the ingots being first brought to a proper heat in special furnaces. The widest plate rolled does not usually exceed 96 inches, though some plates which are rolled are about 102 inches wide. The general range in the thickness of the plates is from 3/16 to 5/8 of an inch.

The other rolling mills of the Bay State Iron Company are idle, and some of them are dismantled, but this mill has been running off and on for the last few years,

rolling plate for the Norway Iron Works. The mill has a capacity of twenty tons of rolled plate per day, and is now running, daily turning out plate for the Bay State Steel Company, which is an entirely distinct company, though it occupies the old steel mill of the old Bay State Iron Company. Houdlette & Dunnells, iron dealers of this city, are the present owners of the Bay State Steel Company and its plant, while the rolling mill is operated by a stock company.—*Com. Bulletin.*

THE ACTION OF HYDROCHLORIC ACID GAS UPON CERTAIN METALS.

AT a recent meeting of the Manchester Literary and Philosophical Society, a paper on the above subject by J. B. Cohen, Ph.D., F.C.S., was read by Dr. A. Schuster, F.R.S.

From certain considerations I was led to believe that hydrochloric acid gas, freed from all traces of water, would not act upon certain of the metals. This idea was further supported by the observations of Gore with liquefied hydrochloric acid (*Proc. Roy. Soc.*, xiv. p. 204), who found that zinc, iron, etc., were scarcely acted upon, and that out of fifteen metals only one, viz., aluminum, was dissolved by the pure liquefied acid.

Preparation of Dry Hydrochloric Acid Gas.—The gas was prepared by the action of ordinary concentrated sulphuric acid, previously well boiled, upon lumps of fused sodium chloride. The gas passed through two wash bottles containing concentrated sulphuric acid (previously boiled), then through a series of eleven bulbs blown on one stem, and placed at an angle of about 45°, also containing concentrated sulphuric acid, and, finally, through a tube about twenty-six inches long and one inch wide, well packed with phosphoric anhydride. The evolution flask was connected by a T piece with the drying apparatus on the one hand and with a tube dipping under dry mercury on the other, the latter serving as a safety valve. All the joints were well secured with thick India rubber tubing, wrapped round with copper wire, and then thickly coated with melted paraffin.

The first metal experimented upon was metallic sodium.

Preparation of Metallic Sodium.—The following method was found to give the best results in preparing clean metallic sodium. It is one, however, which requires the exercise of patience, because often as many as a dozen of the tubes employed break before a successful operation is achieved. A clean glass tube, about 1¼ feet long and ¾ inch diameter, is drawn out at one end into a pear-shaped bulb. This is placed vertically in a clamp with the pear-shaped bulb downward. This may be called the bulb end. Through the bulb end a current of coal gas is passed, until most of the air is displaced. A plug of glass wool is meanwhile introduced through the upper end, so as to fall over the constricted part of the tube, and above this pieces of clean dry sodium are placed, so as to fill about one-half of the upper portion of the tube. The tube is then closed at the upper end with a cork and sealed at the lower end before removing the connection with the coal gas delivery tube. The cylindrical part is now sealed. There still remains in the tube a considerable quantity of air.

To absorb this, the sodium is melted at a gentle heat over the flame, allowed to cool, and the operation performed repeatedly for two or three days, the tube being held in a horizontal position. The sodium is now filtered through the glass wool into the pear-shaped bulb. This is done as follows: The sodium is first melted and the tube tilted with the bulb end downward. On heating the bulb, bubbles of gas are driven through the melted sodium, and on cooling, the tube being still held vertically, the sodium passes slowly into the bulb through the glass wool, which retains the unmelted oxide. This process of filtration may be hastened by warming at the same time the upper part of the tube. If sufficient time has been allowed, and the remelting of the sodium often enough repeated, the metal runs through and has a bright metallic surface. Out of a large number of tubes prepared in this way, only two were successful.

The glass easily cracks on warming the metal when firmly adhering to the walls. The pear-shaped bulb is now sealed off and the sealed ends doubled round in the forms of hooks. The bulb is placed in one compartment of a tube drawn out in the middle; the other compartment is filled with phosphoric anhydride and separated by a plug of glass wool. This tube is connected with the hydrochloric acid apparatus, the compartment containing the bulb being attached to the phosphoric acid tube of the hydrochloric acid apparatus. The other end is connected with a wash bottle of concentrated sulphuric acid. All the joints having been carefully secured, hydrochloric acid gas is slowly bubbled through the apparatus for several hours (both before and after attaching the sodium tube), until a sample of gas issuing from the last wash bottle is entirely absorbed in water. The tube containing the sodium is also heated gently while the gas is passing through, to drive off traces of moisture possibly adhering to the sides. The sodium tube is now sealed off at both ends, and the bulb broken by allowing the hooked ends to fall sharply against the end of the tube. The following results were then noted in two experiments:

1. The sodium retained its metallic appearance for a few weeks, and it slowly assumed a dark gray color; finally, after several months, a deeper violet gray.

2. The sodium lost its metallic appearance much more quickly, and after a few weeks became dull black, like charcoal. This blackness did not extend far below the surface. That portion of the metal attached to the glass retained its mirror-like appearance.

The composition of this black compound has not been further investigated; but it may possibly be a subchloride of sodium.

Experiments with metallic aluminum point to the fact that it is unacted upon by the gas when dry, whereas, as is well known, it is readily tarnished by moist hydrochloric acid gas, and dissolves in the liquefied acid.

These experiments, which have for the present been discontinued, owing to want of time, will be taken up again, and a large number of facts, if possible, collected.

NEW GALVANOMETER.

PROFESSOR JAMES BLYTH, F.R.S., has devised a galvanometer whose deflections are proportional to the current strength, whatever their range. This is an improvement on the ordinary galvanometers, inasmuch as these do not give readings strictly proportional to the current strength when the deflections are large. The new apparatus is similar in principle to the device of Faraday for showing the continuous rotation across the lines of magnetic force of a horizontal radial conductor carrying a current and having slipping contacts at its center and circumference. It consists of two bundles of magnetized steel wires, made in the form of cylinders having narrow axial holes. These are fixed with their axes in the same vertical line, separated by a narrow gap, and so that the north poles of the one set of magnets face the south poles of the other. In this gap there is a sensibly uniform magnetic field with vertical lines of force. In the gap there is a thin circular disk of vulcanite, having a central mercury cup, surrounded by a concentric mercury cup at a short distance from it. A stout brass rod, having a thick piece of copper wire rigidly attached at right angles to its lower end, is so placed that its lower end dips into the central mercury trough, while its upper is suspended from a long, fine, torsion wire of steel or silver. The outer end of the copper wire is bent down so as to dip into the concentric mercury cup. Stout copper wires are led from the mercury cups to terminals on the base of the instrument, and when the current is brought by these terminals through the copper wire it moves round in the magnetic field. The vertical brass rod acts as an axis for it, and carries a long pointer at its upper part, which indicates the deflection of the copper wire or radial conductor on a suitable scale of equal divisions, which may represent amperes. The whole apparatus is inclosed so as to shield it from air currents. The turning moment of the electro-magnetic force on the indicating axis is balanced by the torsional moment of the wire. Thus, let

i = the current strength.
a = the length of the radial wire.
N = the magnetic induction.
A = the torsion constant.
θ = the angle of equilibrium.

Then,

$$\tfrac{1}{2}\, i\, a^2\, \mathrm{N} = \mathrm{A}\, \theta\,;\ \text{or } i = \frac{2\ \mathrm{A}}{a^2\, \mathrm{N}}\, \theta,$$

which shows that the current is proportional to the angle of deflection. In the actual apparatus, the mercury cups are made on the principle of the button hole ink bottle, so as to prevent the mercury from being spilled when the instrument is moved about or knocked over.

NEW USE FOR THE MICROPHONE.

THE microphone is now being used in Germany for the purpose of detecting loss of water through leakage in town mains. The apparatus consists of a steel rod, which is placed upon the cock in the neighborhood of which the leak is suspected, and a microphone attached to the upper end of the rod. A dry battery and a telephone complete the equipment. No sound is heard in the telephone if the cocks are closed and no leak occurs; but a leak of even a few drops through a badly fitting cock causes sufficient vibration in the pipe to affect the microphone and to give audible sound in the telephone. At the recent meeting of gas and water engineers in Eisenach, it was stated that the apparatus is so simple to handle that, with a little practice, ordinary workmen are able to detect and localize any leak.

TELEPHONE RELAYS.

THE reduction in power which takes place in the articulation from telephone receivers when the latter are worked on a long line subject to considerable leakage naturally suggested the employment of a relay which would enable the current which actuated the receiver to be re-enforced. We believe, however, that all attempts to effect what is required has hitherto proved futile. An examination of the conditions under which telephone receivers and transmitters actually work will show that failure must necessarily result. Indeed, it is somewhat surprising that it could be imagined that success could be achieved. If we compare the conditions under which ordinary telegraph relays and suggested telephone relays have to work, it will be seen that great differences exist. In the case of a telegraph relay, practical experience shows that a very slight pressure of the relay tongue against its contact stop serves to close the current of a battery of practically any required strength, and that the removal of the relay tongue from its contact serves to break this circuit. In fact, the pressure of a grain or two on the relay tongue will close the circuit of a battery sufficiently strong to exert a magnetizing force on a magnet equal to a pull on its armature of several pounds, and the removal of this pressure from the relay tongue will open the local circuit and remove the pull on the armature. Now it is obvious that if it were found that the few grains pressure of the tongue of the relay were only capable of closing the circuit of a very weak local battery, which should give to a local magnet a magnetic force of a few grains only, then there would be no use whatever in such an arrangement. In other words, so long as the force capable of being brought locally into action does not exceed the original force which brings it into action, then nothing is gained by such a combination. Practical experience has proved most conclusively that the intensity of the tones given out by a telephone receiver joined up on short circuit with a microphonic transmitter can never be made to exceed, or, indeed, to approach, the intensity of the sound spoken against the diaphragm of the transmitter, *no matter what battery power be used.* It follows, therefore, that the power with which the diaphragm of the receiver vibrates must be much less than the power with which the transmitter diaphragm vibrates. In other words, a pressure of say one grain against the transmitter diaphragm only causes the receiver diaphragm to be moved with a force of a fraction of a grain, say ½ a grain. If, therefore, this receiver diaphragm be connected to the diaphragm of another transmitter, in other words, if a relay be formed, then the force with which the diaphragm of a receiver connected to this transmitter would move, *no matter what the battery power may be*, would be ¼ of a grain only. Thus the effect of a relay would actually be to reduce, not to increase, the effect. If the variation power of a telephone transmitter were the same with every current strength, then an increase of battery power should produce a proportional increase of effect, but this is known not to be the case in transmitters as at present constructed, and unless some new departure be made it seems certain that any working on the old lines must be mere waste of time.—*Electrical Review.*

ELECTRIC SPEED INDICATOR.

M. AUGUSTE HERMITE proposes the use of intermittent light to indicate the speed of engines or other turning bodies. His plan is to illumine a Geissler tube by the sparks of an induction coil giving a constant and known vibration per second, say, from 30 to 40, each vibration giving a corresponding flash of the Geissler tube. By optically arresting the moving objects at different points of their course, he proposes to obtain their speed. For example, if a disk of cardboard be made to revolve by clockwork at a uniform and known speed, say one turn per second, and if it be lighted by the Geissler tube giving 30 flashes per second, the disk will be seen 30 times per second—that is, while it makes one revolution; and if there be a visible spot on the surface, thirty spots will be seen. If the disk turns ten times per second, the succession of images will disappear; owing to the persistence of impressions on the retina, the disk will appear to be immovable, and three spots will be seen on the circumference occupying fixed positions. If the number of turns of the disk be equal to the number of flashes of the Geissler tube, the disk will seen to be immovable. A printed page revolved in this way could be read as if it were fixed.

ON ELECTROLYTIC CONDUCTIVITY.*

By Prof. BOUTY.

THE author first describes Lippmann's method of measuring the resistance of electrolytes, viz., by tapping off and measuring the E.M.F. between two points of the liquid contained in a cylindrical tube, and comparing this with the E.M.F. tapped off a length of known wire included in the same battery circuit as the liquid. He proceeds to use it also for determining the polarization of either electrode, by measuring the E.M.F. between one of the main electrodes supplying current to the liquid and one of the tapping electrodes, using the obvious relation

$$e = r\,\mathrm{c} + p$$

in order to find p, the polarization.

With platinum electrodes and acidulated water he thus reckons that with a current of average intensity of about 8 × $^{-8}$ amperes per square centimeter, the polarization of the electrode rises as follows:

	Polarization of the cathode is	Polarization of the anode is
In 5 minutes	0·056 volt.	0·103 volt.
" 40 "	0·063 "	0·166 "
" 60 "	0·065 "	0·175 "

He then applies a slightly stronger current, but as it is very variable, I do not see that the numerical results obtained are much good. However, the idea is that the polarization of the cathode attains a maximum and begins even to diminish, while that of anode goes on increasing.

He then measures the resistance of acid water in a long siphon tube, and considers that it is independent of current intensity, and asserts: "*A liquid has only a single way of conducting electricity, whatever may be going on at the electrodes. The expressions 'metallic conductivity' and 'electrolytic conductivity' ought to disappear from science.*"

ELECTROLYSIS OF MIXTURES.

A number of mixed salts are tried, one of them being always a salt of copper. Results are given for the electrolysis with copper electrodes of a mixture of sulphate of copper and sulphate of zinc, saturated in the cold, and are analyzed thus: "For current intensities from 5 to 12 ten-thousandths of an ampere per square centimeter the polarization of the anode is constant and equal to 0·0088 volt; but that of the cathode varies enormously. For an intensity 2·9 (ten-thousandths of an ampere as before) it is already 0·02 volt. It increases slowly with the current, and is sensibly constant for the same current when prolonged. But at an intensity 8·6 a new phenomenon is produced. Polarization increases with time, first very slowly, then more and more rapidly, going from 0·04 to 0·65 volt. At the same time, one notices that the metallic and brilliant deposit of pure copper which one had hitherto obtained is displaced by a ruddy and non-adhesive deposit. In proportion as it is produced the polarization increases, and the deposit overspreads the electrodes with increasing rapidity.

"Finally, augmenting the current still more, the deposit passes gradually from red to black, while polarization increases in a continuous manner, and for a sufficient current intensity the deposit acquires anew a certain adherence. It is then dark gray, very rich in zinc, and recalls by its aspect deposits of zinc obtained from impure commercial sulphate of zinc.

"*As for the conductivity of the liquid, it remains constant all the time in spite of the variety of electrolytic actions*, to which a study of polarization and aspect of deposit bear witness. . . . The same *kind* of thing happens with other proportions of $CuSO_4$ and $ZnSO_4$. . . . .

"One may further remark that the specific resistance of the liquid passes through a minimum for a certain

* Abstract by Oliver Lodge, made for the British Association Committee on Electrolysis, 1886.

composition of the mixture. It is then inferior to the resistance of even a saturated solution of one of the salts, and *a fortiori* to that of the same salt diluted down to the strength in which it occurs in the liquor *So the molecules of two mixed salts take part in the transport of electricity, even when one of the two metals is deposited on the cathode.*"

All the variations of polarization in the above case are then simply and naturally explained by the fact of exhaustion, in the liquid near cathode, of the salt of the metal being deposited, except in so far as diffusion replenishes it. With strong currents it is therefore plainly necessary for zinc to be deposited as well as copper, and it is equally obvious that this zinc will tend to clear itself off again by local action.

The author then goes on to observe that very similar complications occur even when only one salt is intended to be present. Thus pure $CuSO_4$ almost always contains a trace of acid, and accordingly, in its solution, hydrogen plays much the same part as zinc has done in the above described experiment. For feeble intensities copper alone is deposited, but for stronger currents the deposit is red and contains some oxide [?]. Hydrogenized copper forms with copper, in fact, local couples in which copper is the attacked element. Evolution of heat by local action has been proved by the use of thermometer electrodes.

Even if $CuSO_4$ contained no acid to start with, it would soon get some by electrolysis, for the solution of anode is never exactly equal to deposit on cathode.

In all these cases one may notice that *electrolytic reactions which go on for the most feeble currents absorb always less heat than those which occur with stronger currents.* This extension to mixtures of the beautiful law announced by Berthelot for the case of electrolysis of a single salt is confirmed by a study of particular cases. For instance, the following table sums up the author's observations on a mixture of $\frac{9}{10}$ by volume of a solution of Na_2SO_4 and $\frac{1}{10}$ of a solution of $CuSO_4$, both pure and saturated when cold. The polarization of anode is so small as to be negligible. The polarization of cathode is given for various intensities of current in ten-thousandths of an ampere per square centimeter.

Current Intensity.	Polarization of Cathode in Volts.	
7	0·042	Brilliant deposit of copper.
10	0·044	
15	0·045	
19	0·051	
31	0·068	
36	0·100	
41	0·162	
44·7	0·298	
45·4	0 859	Brown deposit.
77	1·366	
150	1·585	Abundant evolution of hydrogen.

The brown deposit of oxide appears as soon as the polarization exceeds 0·28 volt. The polarization increases first very rapidly, then slowly, and its limit is very nearly the number (1·428 volt) which corresponds to the decomposition of Na_2SO_4 between copper electrodes. (It is slightly sophisticated by the extra resistance of gas bubbles then given off.) To sum up: First is decomposed $CuSO_4$, which theoretically consumes no energy (the electrodes being copper), then comes in the decomposition of acid water (0·28 volt), finally that of sulphate of soda (1·424).

As for the conductivity of the mixture, it remains perfectly invariable in spite of the variability of the electrolytic reactions.

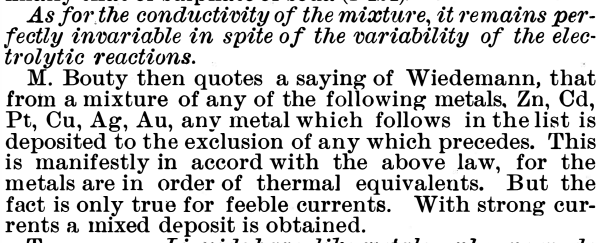
M. Bouty then quotes a saying of Wiedemann, that from a mixture of any of the following metals, Zn, Cd, Pt, Cu, Ag, Au, any metal which follows in the list is deposited to the exclusion of any which precedes. This is manifestly in accord with the above law, for the metals are in order of thermal equivalents. But the fact is only true for feeble currents. With strong currents a mixed deposit is obtained.

To sum up: *Liquids have, like metals, only one mode of conducting electricity. Also, they have, like metals, only one contact E.M.F. with an electrode of invariable composition.* But the result of electrolysis being to modify both electrode and liquid round it, their contact E.M.F. alters in a variable manner—whence polarization.

[NATURE.]

A LECTURE EXPERIMENT ON THE EXPANSION OF SOLIDS BY HEAT.

I VENTURE to call attention to a simple and effective way of demonstrating the linear expansion of solids when heated, first suggested, I think, by M. Kapoustine



(*Journal de Physique*, December, 1883, p. 576). It answers at least as well as the system of levers known as "Ferguson's pyrometer," which is usually employed for the purpose, while the cost of the apparatus is almost nothing, and any one can make it in ten minutes.

The principle is, to magnify the slight extension of a bar by causing the end to roll upon a needle, and thus turn the latter round and move a pointer attached to it through a sensible arc.

The figure given above will show the nature of the apparatus.

A small flat rod of the material to be examined, such as brass, iron, or glass, about 30 cm. long, 1 cm. broad, and 2 or 3 mm. thick, is laid upon two wooden blocks, placed about 25 cm. apart. A weight is put upon one end of the rod to keep it from moving; under the other end, at right angles to the length of the rod, is laid a fine sewing needle, to the eye end of which a light pointer of straw, about 16 or 20 cm. long, is attached by sealing wax. Behind the pointer (which is painted black) a screen of white cardboard is fixed on the wooden block by drawing pins.

When the rod is heated by a lamp flame, the free end of it, as it expands, moves forward upon the needle and rolls it round, its movement being shown by the motion of the pointer. Even the slight expansion of a slip of glass is thus easily rendered evident to a class.

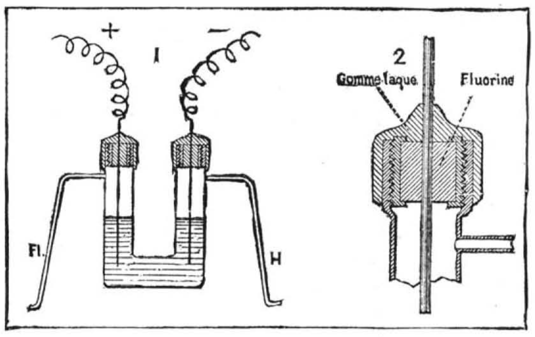
I have constructed for my own use a double apparatus on the same principle, in which the surfaces between which the needle rolls are of brass, ground true and flat. Two bars of different materials lie side by side, each having its own bit of needle and aluminum pointer, ranging over the same scale. They are heated equally by a broad flame (spirits of wine in a wide trough), and the difference of expansibility as well as the fact of expansion by heat is thus shown.

It is advisable to counterpoise the pointer by putting a shot or two into the lower end of the straw which projects below the needle, and cementing them in by sealing wax. Also, before the experiment is shown to an audience, it is well to make sure that the needle rolls fairly and freely between the bar and the block. Such precautions, however, are not in the slightest degree necessary for school work; for there is always one thing which gives the typical boy greater pleasure than to see an experiment succeed, and that is—to see it fail.

Eton College. H. G. MADAN.

THE ISOLATION OF FLUORINE.

THE chemist does not confine himself to a study of the properties of the substances that exist upon the surface of the globe, but decomposes and analyzes them, and extracts from them bodies that are not



FIGS. 1 AND 2.—SECTION OF APPARATUS FOR DECOMPOSING HYDROFLUORIC ACID.

found isolatedly in nature. Gold, silver, copper, and sulphur are indeed found in a native state in certain geological formations, but aluminum, sodium, iodine, chlorine, and most simple bodies have been isolated by the chemist's art, and are met with on our globe hidden in combinations with other substances only.

By combining the bodies thus isolated, the chemist succeeds in manufacturing a large number of entirely factitious products. Besides, the classification of the bodies obtained, through the analogies presented by their combinations, permits him to foresee the existence of compounds that ought to occupy a definite place in the *series*. One of the most interesting of such series or families among the metalloids is that of chlorine, along with which is included iodine, bromine, and fluorine. Although the latter has been placed in this family, its existence up to the present has been wholly hypothetical. It has been unknown, and has never been isolated. It was placed by supposition in this family because we were acquainted with hydrofluoric acid—a very volatile substance that has considerable analogy with hydrochloric, hydrobromic, and hydriodic acids. These three last are formed of one atom of hydrogen with one of chlorine, bromine, and iodine respectively. Hydrofluoric acid seemed as if it

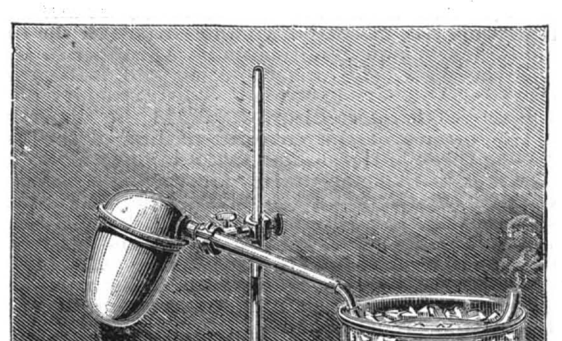


FIG. 3.—ARRANGEMENT OF THE PLATINUM RETORT FOR PREPARING HYDROFLUORIC ACID.

were formed, in the same way, of hydrogen and a simple body as yet unknown—fluorine.

One of our most distinguished chemists, Mr. H. Moissan, has recently succeeded, for the first time, in decomposing hydrofluoric acid and separating it into its constituent elements—hydrogen and fluorine.

The discovery of fluorine is a matter of great importance, since, while giving science a new element, it offers a wide theoretic range.

Mr. Moissan succeeded in decomposing the acid by an electric current furnished by Bunsen piles. Fig. 1 gives the arrangement of the apparatus. Hydrofluoric acid, properly prepared, is introduced into a small U-shaped platinum tube, whose two branches are closed by means of a fluorspar stopper. The stoppers, the details of which are shown in Fig. 2, are traversed by a platinum rod, which leads the current to the liquid to be decomposed. The fluorspar is provided externally with a platinum screw. The whole is sealed during the operation with gum lac. The hydrofluoric acid attacks glass and all known substances save fluorspar (fluoride of calcium) and platinum. It became necessary therefore to take peculiar precautions in submitting it to the action of the electric current.

After hydrofluoric acid has been put into the tube thus closed, an electric current is passed into it, and there is obtained a combustible gaseous body at the positive pole which possesses new properties, and which Mr. Moissan has recognized as fluorine; and at the negative pole a combustible gas, which is hydrogen. As there is some difficulty connected with the preparation of hydrofluoric acid, we shall describe Mr. Moissan's process. He says: "In order to obtain pure, anhydrous hydrofluoric acid, we begin by preparing hydrofluorate of fluoride of potassium, and take, as we do so, all the precautions pointed out by Mr. Fremy. When we have obtained this salt in a state of purity, we dry it in a water bath at 100 deg. C., and the platinum capsule containing it is afterward placed in a vacuum along with concentrated sulphuric acid and two or three pencils of potash fused in a silver crucible. The acid and potash are replaced every morning for a fortnight, and the vacuum is constantly kept up. It is necessary, during the desiccation, to take care to pulverize the salt every day in an iron mortar, in order to renew the surface. When the hydrofluorate no longer contains any water, it becomes pulverulent, and is then capable of serving for the preparation of hydrofluoric acid. It must be remarked that the hydrofluorate of fluoride of potassium, well prepared, is much less deliquescent than the fluoride. When the hydrofluorate is very dry, it is quickly introduced into a platinum retort which has been rendered dry at a red heat a short time previously. It is kept at a medium temperature for an hour and a half, so that decomposition may proceed slowly. The first portion of hydrofluoric acid formed, which carries along with it slight traces of water that might remain in the salt, we lose. We then connect the platinum receiver, and submit the retort to a greater heat, while at the same time allowing the decomposition of the hydrofluorate to proceed slowly. We afterward surround the receiver with a mixture of ice and salt (Fig. 3), and, from this moment, all of the hydrofluoric acid begins to undergo condensation, and furnishes a limpid liquid, which boils at 19·5 deg. C., and which is very hygroscopic and gives off, as well known, abundant fumes in the presence of atmospheric humidity."

The decomposition of the hydrofluoric acid in the platinum tube likewise necessitates great precaution. It is necessary, also, to operate at a low temperature, by placing the tube in a freezing mixture. Mr. Moissan describes this part of the experiment and the properties of the new body as follows:

"While the hydrofluoric acid is preparing, the carefully dried U-shaped tube is fixed, by means of a stopper, in a cylindrical glass vessel and is surrounded with chloride of methyl (Fig. 4). Up to the moment of introducing the hydrofluoric acid, the tubes are connected with drying test glasses containing fused potash. In order to cause the acid to enter this apparatus, it may be absorbed, through one of the lateral tubes, in the very receiver in which it is condensed.

In some experiments, we have directly condensed the acid in the U-shaped tube surrounded with chloride of methyl; but, in such a case, it must be seen that the tubes do not get clogged up by the small quantities of hydrofluorate carried along, as this would infallibly lead to an explosion or ejection, both of which would prove very dangerous with so corrosive a liquid.

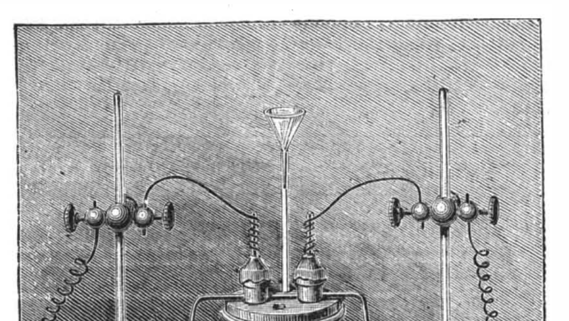


FIG. 4.—APPARATUS FOR DECOMPOSING HYDROFLUORIC ACID.

"After a definite bulk of the acid has been introduced into the platinum apparatus, cooled by chloride of methyl, in quiet ebullition at a temperature of —23 deg., we pass into the electrodes the current produced by 20 Bunsen couples mounted in series. An amperemeter placed in the circuit permits of keeping track of the current's intensity. If the hydrofluoric acid contains a small quantity of water, either through want of care or intentional addition, some ozone will be disengaged at the positive pole that will have no action upon the

crystallized silicium. In measure as the water in the acid is thus decomposed, we find, through the amperemeter, that the liquid's conductivity is rapidly decreasing. With perfectly anhydrous hydrofluoric acid, the current no longer passes. In several of our experiments, we succeeded in obtaining so anhydrous an acid that a current of 25 amperes was totally arrested.

"In order to render this liquid conductive, we add to it, before the experiment, a small quantity of dry, fused hydrofluorate of fluoride of potassium. In this case, the decomposition occurs continuously, and we obtain hydrogen at the negative pole, and at the positive a regular disengagement of a colorless gas in which the cold, crystalline silicium burns brightly, and becomes converted into a fluoride. This latter gas has been collected over mercury and perfectly identified.

"Deville's adamantine boron likewise burns, but with greater difficulty, and becomes converted into a fluoride. The small quantity of carbon and aluminum that it contains interferes with the combination. Arsenic and antimony in powder combine with this body with incandescence. Sulphur inflames in it, and iodine combines with it, with a pale flame, and loses its color. This gas decomposes water in a cold state and produces oxygen and hydrofluoric acid. This oxygen is ozonized, just as happens in all preparations of oxygen that are made in a cold state.

"Tetrachloride of carbon is decomposed by fluorine. As soon as this latter comes into contact with the liquid, chlorine is produced, according to Dumas' law of substitutions. Chloride of carbon continuously absorbs fluorine and disengages chlorine. Sulphide of carbon takes fire in the presence of fluorine.

"The metals are attacked with much less energy. This, we think, is due to the fact that the small amount of metallic fluoride formed prevents the attack from going further. Iron and manganese in powder and slightly heated, burn, and give off sparks. Potassium and sodium become incandescent in contact with fluorine, and furnish fluorides whose crystalline form is characteristic. Mercury entirely absorbs the gaseous element, and furnishes a fluoride of a bright yellow color.

"Organic bodies are violently attacked. A bit of cork placed near the extremity of the platinum tube through which the gas is escaping immediately becomes carbonized and inflames. Alcohol, ether, benzine, essence of turpentine, kerosene, and sulphide of carbon take fire in contact with it.

"The gas produced at the negative pole is hydrogen, which burns with a pale flame, and produces none of these reactions.

"When the experiment has lasted several hours, and the quantity of hydrofluoric acid remaining at the bottom of the tube is no longer sufficient to separate the two gases, the latter recombine in the apparatus with a violent detonation. Such detonation occurs, moreover, every time that the current is reversed, and that fluorine is produced in an atmosphere of hydrogen. This seems to demonstrate that, even in darkness, hydrogen and fluorine combine to reproduce hydrofluoric acid. We have satisfied ourselves, by direct experiments made with ozone saturated with hydrofluoric acid, that a like mixture produces none of the reactions above mentioned. The same is the case with gaseous hydrofluoric acid. Finally, we may add that the hydrofluoric acid (as well as the hydrofluorates) used was absolutely free from chlorine. The gas obtained in our experiments was therefore either fluorine or a perfluoride of hydrogen."

In a later note presented to the Academy, Mr. Moissan demonstrates that the gas obtained at the positive pole, in the electrolysis of hydrofluoric acid, is entirely free from hydrogen; consequently, this new body is fluorine. This is a splendid and important discovery for chemists to register.—*La Nature.*

BUTTER.*

By E. DUCLAUX.

THE author has determined the proportions of volatile acids in butters by means of the method of fractional distillation described in 1865 (*Ann. Chim. Phys.*), the butters examined being a series of prize Normandy butters exhibited at the February exhibition in the Palais d'Industrie. The following results were obtained:

	1.	2.	3.	4.	5.	6.	7.	8.
Water	12·40	13·36	12·28	10·72	13·34	11·62	14·00	13·03
Fat	86·71	85·48	86·76	88·30	86·01	86·52	85·31	86·33
Milk sugar	0·16	0·20	0 17	0·13	0·20	0·30	0·20	0·11
Casein and salts	0·73	0·96	0 79	0·85	0·45	1·56	0·49	0 53
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Caproic acid (p. c.)	2·10	2·18	2·17	2·23	2·26	2·00	2·08	2·19
Butyric acid (p. c.)	3·55	3·52	3·53	3·60	3 65	3·38	3 52	3·46
Sum of the acids	5·65	5·70	5·70	5·83	5·91	5·38	5·60	5·65
Ratio	2·1	2·0	2·0	2·0	2·0	2·1	2·1	2 0

With the exception of No. 6, in which the proportion of casein is abnormally high, the composition of all these butters is remarkably uniform, and this is especially noticeable in the combined amounts of the volatile acids and the ratio between the two acids. It may be said, therefore, that the constitution of the glycerides of the volatile acids is identical in all these butters. Further experiments are necessary, however, to ascertain the influence of breed, locality, and season. A sample of butter from the district of the Meuse, derived from an entirely different breed, showed exactly the same ratio between the two volatile acids.

It is generally supposed that the rancidity of butter is due to a butyric fermentation resulting from the action of microbes derived from the air on the albuminoids present in the butter. Some very old and salt butters imported from Brazil were found, however, to contain casein in its original condition, and when the butter was washed, the water was free from microbes. The free acid in the butter had, however, increased to ten or twenty times its original amount. It follows that the rancidity of butter is not due to microbes, but is the result of a spontaneous decomposition of the glycerides analogous to that which Berthelot has observed in the case of other ethereal salts. This decomposition is accelerated by the presence of water and free acid, but is more or less retarded by salt and borax. Of the different ethereal salts present in butter, butyrin is the least stable, caproin more stable, and the glycerides of the non-volatile acids still more stable.

This spontaneous decomposition is complicated by the action of air, microbes, and light. The action of air and light results in an absorption of oxygen with formation of carbonic anhydride, the quantity of which is always less than that which corresponds with the amount of oxygen absorbed. The products of oxidation are various, but the most important is formic acid. Oxidation, however feeble, first attacks those substances to which the butter owes its flavor and odor. As oxidation progresses, an odor of tallow is developed, this action being especially rapid in direct sunlight.

In addition to the action of air and light, there is the action of microbes, and especially of cryptogamic vegetations, which cover the mass of the butter with their loose, almost invisible mycelia. This action accelerates the decomposition of the glycerides, and at the same time brings about the alteration of the nitrogenous compounds present in the butter. If the albuminoids are present in small quantity, butyric acid is formed, and its presence accelerates the decomposition of the glycerides, more free acid being liberated up to a certain point, beyond which the acid is only set free in quantity equal to that which is oxidized or evaporates. The butter remains colorless except where it is in contact with mycelial tubes. When the quantity of albuminoids is large, the mass becomes alkaline, and the fatty matter darkens in color, owing to its gradual conversion into a black resin, completely soluble in alcohol and in alkaline solutions. The resin is also formed in sunlight in presence of an alkali. These facts explain the gray or black color of old cheese.

* From *Compt. Rend.*, cii., 1022–1024, 1077–1079. Reprinted from the *Journal of the Chemical Society.*

[AMERICAN CHEMICAL JOURNAL.]

ABSORPTION TUBES FOR THE ESTIMATION OF CARBONIC ACID IN ATMOSPHERIC OR GROUND AIR.

By THOMAS C. VAN NUYS.

HAVING employed Pettenkoffer's absorption tubes* in connection with an apparatus described and illustrated in this Journal, Vol. 8, No. 3, in estimating carbonic acid in the air, I found that the Pettenkoffer tubes yielded results too high and subject to greater variation than those obtained with my apparatus. This I concluded was due to the absorption of carbon dioxide from the air by the baryta after a measured quantity of air had passed through the tubes and before titrating with the oxalic acid solution. To overcome this difficulty I devised the tubes represented in Fig. 1. They were made by Mr. Emil Greiner, 79 Nassau St., New York. As each tube is of the same construction, the description of one will answer for both.

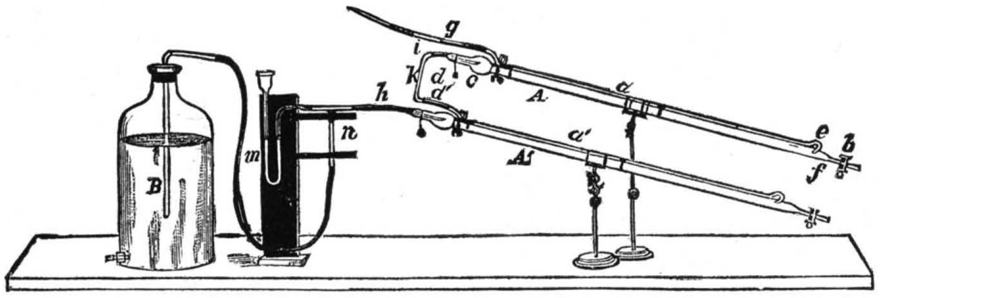


FIG. 1.

Tube A, from the stop cock, *b*, to the bulb, *c*, is 90 cm. in length, and its external diameter is 16 mm. and internal diameter about 11 mm. The outside diameter of the enlarged portion or bulb, *c*, is 4 cm. The capacity of the tube from the stop cock to the bulb is 96 cc. The stopper, *d*, fits with a ground surface in the tube, and is drawn out at either end. A rubber tube fits over the distal end, and the other end is bent and drawn out to a certain extent. This extremity of the stopper is therefore directed toward the upper part of the surface of the enlarged portion of the tube. Passing through the stopper longitudinally is an opening 4 mm. in diameter, except at its proximal extremity, where the diameter is about 2 mm. The small tube, *a*, is fastened to the absorption tube by having rubber tubing placed over it in two places and secured by fine cord. Its outside diameter is 6 mm. Within a few centimeters of the stop cock the tube, after making the curve, *e*, enters the absorption tube and is welded with the latter at point of entrance.

In the absorption tube it is drawn out and somewhat curved in its course, so that its extremity, *f*, is directed toward the center of the absorption tube. The diameter of the orifice of the tube at *f* is less than 1 mm. At the enlarged portion of the absorption tube the small tube, *a*, is bent, and terminates nearly opposite and about 5 cm. from the stopper. The aspirator bottle, B, is connected with the absorption tube, A', by tubing. The manometer, *m*, communicates with the absorption tube and aspirator bottle by means of the T tube, *n*. The construction of the stopper of each absorption tube and the tube, *a* or *a'* (Fig. 1), as it terminates in the absorption tube are illustrated in Fig. 2.

Fig. 3 represents one of the absorption tubes connected with the flask, B. The flask is provided with a rubber stopper having three holes, through one of which a bent glass tube passes, which is connected with the absorption tube by means of a rubber tube. The long tip of the burette, *a*, passes through the second hole, and through the third hole the bent end of the calcium chloride tube, *b*, passes. This tube is filled with pumice saturated with a strong solution of sodium hydrate. The calcium chloride tubes, *c* and *d*, contain soda lime. The lower end of each tube is closed with a cork stopper having a small perforation, and the soda lime is secured in place by some cotton in either end. The rubber tube, *j*, connected with an aspirator bottle containing water about one meter above the upper end of the absorption tube, is attached to the T tube, *e*. Besides showing the plan of the absorption tubes, Fig. 1 illustrates their position and relation to each other when they are being filled with air free of CO_2, and when the process of absorbing the carbonic acid of the air is in progress.

* Annalen der Chemie, Suppl. Bd. 2, 23; Zeitschrift fur analyt. Chemie, 1, 495.

By Fig. 3 the processes of filling, emptying, and washing them are illustrated.

The barium hydrate solution I used is made by dissolving about 3·5 grammes in 1000 c.c. water, and to

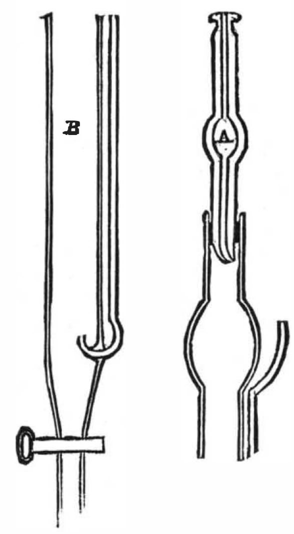


FIG. 2.

this solution about 2 grammes barium chloride is added to react on any potassium or sodium hydrate that may be present as an impurity. If the solution formed is not clear, it should be filtered into a tubulated or aspirator bottle, which, to prevent the ingress of air containing carbon dioxide, is provided with a rubber stopper with which a simple calcium chloride tube is fitted with its drawn out extremity bent, and the tube filled with pumice saturated with a strong solution of sodium hydrate. The oxalic acid solution used is prepared by dissolving 2·8636 grammes pure acid in 1000 c.c. water. Solution of oxalic acid of this strength was first employed by Pettenkoffer; 1 c.c. of it equals the saturating power of 1 milligramme, or 0·5084 c.c., carbon dioxide at normal temperature and pressure. To ascertain how much of the oxalic acid

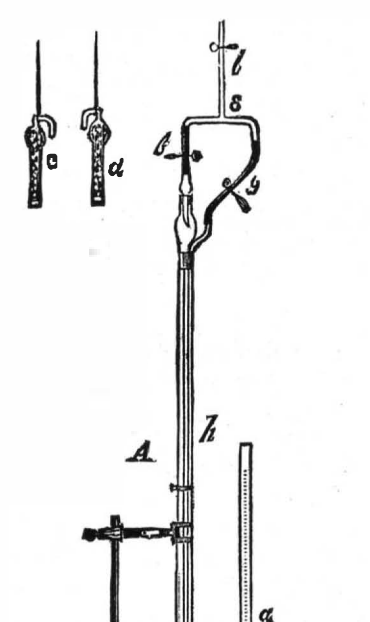


FIG. 3.

solution is required to neutralize 50 c.c. of the barium solution, the titrations should be carried on in the absence of air containing carbon dioxide.

To accomplish this, the method of F. Schulze * may

* Zeitschrift fur analyt. Chemie, 9, 292.

be employed. Into a 100 c.c. flask, having been cleaned and dried, a piece of sodium hydrate is suspended by means of a wire. The flask is closed by a stopper, allowed to stand a few hours, when the sodium hydrate is carefully drawn out. A piece of rubber sheet having a small perforation is placed over the mouth of the flask and secured by a rubber band, and into the flask through the small opening in the rubber sheet a few drops of an alcoholic solution of rosolic acid are introduced by means of a small pipette, after which 50 c.c. of the baryta solution are introduced from a pipette which has been filled by Pettenkoffer's method, when the tip of a 25 c.c. burette containing the oxalic acid solution is introduced through the perforation, and the solution is titrated until the red color of the rosolic acid disappears.

With as great security against the presence of carbonic acid, the flask in Fig. 3 may be employed by having been dried, two or three drops rosolic acid solution introduced, the bent glass tube pushed further down into the flask, the rubber tube attached to a wash bottle containing a strong solution of sodium hydrate, and a U-shaped calcium chloride tube containing soda lime and cotton, the latter next the flask, and through these the air is drawn into the flask by attaching the end of the calcium chloride tube, *b*, to an aspirator. When three or four liters of air have been drawn through, the rubber tube is secured by the pinch cock. Into the free end of the tube filled with water the tip of a 50 c.c. pipette filled with the barium solution is introduced, and by loosening the pinch cock the solution is let into the flask. Some water is introduced in the same way, so as to wash all of the barium solution from the tube, when the solution is titrated with the oxalic acid solution in the burette. When an agreement is reached, it is found that from 23·5 to 24 c.c. oxalic acid equal 50 c.c. of the barium hydrate solution. Both absorption tubes are so connected that when the tube, *g* (Fig. 1), is attached to a wash bottle containing a solution of sodium hydrate, and two U-shaped calcium chloride tubes containing soda lime, and some cotton in the tube next to tube, *g*, the absorption tubes can readily be filled with air free of carbon dioxide, but the air should not be drawn through with great rapidity, and the cotton should be in quantity sufficient to arrest any particles of soda lime that may be separated by the air.

The absorption tubes having been filled with air free of carbon dioxide, the rubber tubes, *gi* and *jh*, are secured by pinch cocks. Each absorption tube is filled with the barium hydrate solution, by placing them in position as in Fig. 3. The rubber tube, *f*, is placed over the bent end of either tube, *c* or *d*. The tip of a 50 c.c. pipette filled to the mark with the barium solution is introduced into the rubber tube, *g*, when the pinch cocks are removed from the tubes, *g* and *f*, and the solution will run through the small tube, *h*, into the absorption tube, after which from 30 to 35 c.c. water are introduced in the same way, when the rubber tube, *g*, is secured by the pinch cock; and that the water may pass down from the end of this tube, connection is made with it and tube, *d*, when the water will descend by loosening the pinch cock. Both tubes having been secured by pinch cocks, the absorption tube is ready for use. The other absorption tube is filled in the same way, and they are connected as before by means of the glass tube, *k* (Fig. 1). The tube, *l*, through which air passes to enter the absorption tubes, is two or three meters long. It cannot well be dispensed with, as there is great liability of the air becoming charged with an increased quantity of carbonic acid by persons remaining any length of time about the apparatus while air is passing through the tubes. I found this true in several instances. For the same reason, the apparatus is placed so that the movement of air, if appreciable, is from the open end of the tube, *l*, toward the apparatus.

Before passing air through the absorption tubes, all rubber tubing making connections is secured by fine iron wire; and to ascertain if the connections are air tight, all of the pinch cocks, except the one securing tube, *g*, are removed, and by turning the stop cock of the aspirator bottle, if air ceases to pass through the absorption tubes, and especially after closing the stop cock of the aspirator, the mercury in the manometer remains stationary, the connections are air tight. When the pinch cock securing the tube, *g*, is opened so that air may enter, it passes through both absorption tubes, and enters the aspirator bottle as the water escapes. By measurement of the latter, taking into account the pressure and temperature, the quantity of air at 0° C. and normal pressure which passed through the tubes is ascertained.

The pinch cock securing the tube, *g*, is gradually opened by means of a metallic wedge, so that air may pass through the absorption tube, A, in small bubbles. If they tend to unite to any great extent, or the current is interrupted, the pinch cock is adjusted so that less air may enter. It will be found necessary to adjust the pinch cock on the tube in the same way, employing a metallic wedge or a pinch cock provided with a screw, so as to regulate the size of the bubbles in the absorption tube, A'. If the operator trust to the adjustment of the stop cock of the aspirator bottle, liability to failure in securing a correct result is very great, as the air bubbles formed are often large, and some carbonic acid may escape absorption. By passing air through the tubes at the rate of three liters per hour, all of the carbonic acid is absorbed. In nearly all of the estimations made with these tubes, eight liters of air were passed through the tubes, requiring about two and a half hours. The temperature of the air, the height of the barometer and of the mercury in the manometer do not receive special attention until near the end of the process, for the reason that should there be changes in temperature or pressure, the current of air through the tubes and the flow of water are so regulated that the volume of air in the aspirator bottle at the expiration of two, three, or four hours corresponds to the volume of water which had escaped the last moment of the process.

For example, at the expiration of two hours the temperature was 8° C., when four liters of air had entered the aspirator bottle; but at the expiration of the fourth hour the temperature was 12° C., the barometric pressure remaining the same. During the last two hours 4000 c.c. air in the aspirator expanded $\frac{4}{273}$ of its volume. $4000 \times \frac{4}{273} = 58·6$. The increase of 58·6 c.c. due to expansion by increase of temperature during the process prevented an equal volume of air from entering the aspirator bottle, consequently 58·6 c.c. water passed out of the aspirator bottle and was measured, while no air passed through the absorption tubes to supply the place.

In the reduction of the volume of air to normal temperature, taking into account the increased temperature as ascertained at the end of the process, the correction is made. It is at once perceived that if the temperature were reduced during the process, a greater volume of air would pass through the absorption tubes than that occupied by the water from the aspirator bottle. For the same reason, to avoid incorrect results arising from change of temperature or barometric pressure during the process, the aspirator bottle is filled to the stopper. In case the aspirator contained air at the beginning of the process, and a change of temperature or pressure took place during the process, the volume of water measured does not represent the volume of air passed through the tubes at the temperature and pressure at the end of the process without taking into account the expansion or contraction of the air in the aspirator at the beginning of the process. As temperature is a very important factor to be taken into consideration in reaching correct results, the water in the aspirator, before beginning the process, should be about the temperature of the air, and the apparatus is placed so as to be protected from the direct light of the sun, to avoid difference of temperature of the air and water in the aspirator at the end of the process. Preparatory to emptying and washing the tubes, the 50 c.c burette, *a* (Fig. 3), is filled with the oxalic acid solution. Two or three drops of an alcoholic solution of rosolic acid are introduced into the flask, B, and it is filled with air free of carbonic acid as above, when the rubber tube, *i*, is closed by means of the pinch cock, and its end is filled with water, as well as the glass tube from the glass stop cock of the absorption tube. The end of the rubber tube is fitted over the glass tube. In this way no air containing carbonic acid can enter the flask. The end of the rubber tube, *f*, is filled with water from the pinch cock and fitted over the bent extremity of either *c* or *d*, and the pinch cock is removed. The glass stop cock of the absorption tube is turned gradually, so that the fluid in the tube passes slowly into the flask, and, when empty, the tube, *f*, is again closed by means of the pinch cock, and the calcium chloride tube disconnected.

The ends of the T tube, *e*, are loosely introduced into tubes, *f* and *g*, and the pinch cock securing tube, *j*, opened to a certain extent, so that the T tube and the ends of the rubber tubes become filled with water, to the exclusion of air. To this end the internal diameter of the T tube should not exceed 3 mm. The pinch cock is removed from tube, *j*, and the pinch cock closing tubes, *f* and *g*, are alternately opened and closed, and the stopper turned so that a stream of water is directed against different parts of the bulb of the absorption tube. With some practice, 75 c.c. water will wash every trace of the barium solution into the flask.

The tube, *i*, is closed with the pinch cock, and the fluid of the other absorption tube is emptied into the flask in the same way. It is not necessary that the barium solution and wash water from both tubes exceed 250 c.c. When the second tube is emptied and washed, the tube, *i*, is closed with the pinch cock, the absorption tube disconnected, and the barium solution in the flask is titrated with the oxalic acid solution in the burette.

That the processes of filling, emptying, and washing these tubes are carried on without the introduction of air containing carbonic acid was proved by omitting the passing of air through the tubes, otherwise carrying on the processes as above, and arriving at the same results as by use of the flask as above in standardizing the barium hydrate solution. The tubes can be filled with air free of carbon dioxide and charged with the barium solution, and the process begun in thirty minutes, and in the same length of time the tubes can be emptied, washed, and the titration made.

The following are the data of one estimation of carbonic acid in the air:

47·9 c.c. oxalic acid solution equal 100 c.c. of the barium hydrate solution.

Process of absorption from 9 A.M. to 11:40 A.M.
Air passed, 8195 c.c.
Thermometer reading at end of process, 20° C.
Barometer reading at end of process, 745 mm.
Manometer reading at end of process, 43 mm.
Vapor tension at 20° C., 17 mm.

$$\overset{\text{Man.}}{43\text{ mm.}} + \overset{\text{V. tension.}}{17\text{ mm.}} = 60\text{ mm.}$$

$$\overset{\text{Bar.}}{745\text{ mm.}} - 60\text{ mm.} = 685\text{ mm.}$$

Volume of air at normal pressure (760 mm.) and normal temperature (0° C.) $= \frac{273}{293} . 8195 . \frac{685}{760} = 6882$ c.c.

In titrating, 44·29 c.c. oxalic acid solution were requred to neutralize the barium hydrate solution; consequently, with the barium solution the equivalent of 3·61 c.c. of the oxalic acid solution is combined with the carbonic acid.

As 1 c.c. of the oxalic acid solution corresponds to 0·5084 c.c. CO_2 at normal temperature and pressure, there is carbonic acid found, $0·5084 \times 3·61 = 1·835324$ c.c., therefore in 10,000 vols. air there are 6882 : 1·835324 : : 10,000 : 2·66 vols.

THE RISKS OF TRANSATLANTIC STEAMSHIPS.

THE decline of the year has been somewhat more fertile than usual in accidents and loss to British shipping, in all parts of the world; and especially in home waters. Irrespective of the formidable gale of October 15 and 16, which swept furiously over our own coast line, and destroyed a great deal of life and property at our very doors, there has occurred an unusual number of casualties to Atlantic steamers. The Great Eastern, also, of widespread frame, has been very near the termination of her quiet and uneventful life; owing either to some difficulty in starting her engines or in clearing away her anchors. The Cunarder Pavonia, belonging to a company which has had such wonderful success in all the great risks of ocean navigation, got ashore during foggy weather in the neighborhood of New York, and had to be beached in order to be saved. The Persian Monarch, under much the same circumstances, does the same thing in the locality of Portland. The Lake Huron, of the Beaver line, strikes upon a rock near Quebec, and immediately fills three compartments.

Two more of the big ships—one of them again a crack Cunarder—are in collision near New York. Captain W. R. Grace, of the National steamer America, after being 42 hours on the bridge of his ship, during what he considered the most terrific gale he had ever experienced, goes quietly to his cabin and dies in a fit of apoplexy.

The Anchoria, another transatlantic steam packet ship, with 700 people on board, breaks down in mid-ocean, by carrying away the shaft of her ponderous propeller. At a later date, and on this side of the rolling sea, near Tarifa Point, we have one of the splendid vessels of the P. and O. Company in collision with an English sailing ship. Her complement of passengers was, possibly, not so large as the Anchoria's, although what they lacked in numbers was, perhaps, made up for in importance, as among the list we read the names of Lord and Lady Rosebery, the Duke and Duchess of Manchester, the Earl and Countess of Annesley, and other prominent personages.

In the November issue of this journal we also find a report of no less 27 cases of casualties, principally made up of strandings and collisions, with the actual loss of 14,000 tons of British shipping and 108 British lives. Perhaps the most interesting and important event in this list was that of the large steamer Anchoria carrying away the shaft of her propeller during a heavy gale from the northwest; and in the difficulties and extra anxieties of a heavy and dangerous sea in that part of the Atlantic 1,100 miles west of Cape Clear. There was a considerable amount of fear and doubt among shipping circles in regard to this ship's safety. She was some 16 days overdue; had 700 people on board; and was known to be crossing the sea of storms at the very worst and windiest time of the year. Such accidents as hers have frequently happened at all seasons in the Atlantic—and very much worse accidents too—the constant fear of which, in the case of the overdue steamer, hangs like a millstone around the necks of all interested individuals. It produced, therefore, a great feeling of relief when the cable flashed the news across from St. John's that the Anchoria with her living freight had safely cast anchor in a good and commodious harbor of the Great West. Beyond the accident to her main shaft, including also the circumstance of two births, and two deaths from natural causes, everything had gone well during the voyage. Except in the hearts of a few timid and nervous passengers during the gale when the accident happened, there had been no manner of serious apprehension or doubt of any kind whatever as to the ultimate safe, if not very happy, termination of the voyage. The captain and his officers determined to keep the ship under sail, and await patiently the completion of repairs, after which they fully expected to be able to pursue their way to the westward at reduced speed. In any case, if repairs could not be effected, they were confident of sooner or later falling in with a steamer, and being towed to a safe harbor. Such accidents as theirs, they knew, had often happened before, and had ended in such manner. Time proved, however, that in their case such anticipations were not exactly realized. The fracture of the shaft, like so many other shaft fractures, gave no warning. The first indication her officers received was a loud, alarming, crashing sound immediately under the saloon just as the ship had passed over, and was still under the impulse of, a wave of unusual magnitude. On realizing the full extent of the accident, and finding the ship falling off from the wind—a very natural consequence to a vessel losing her steerageway—sail was at once made upon her, under which she rode out the gale with no further apprehensions as to her safety, and no further trouble than a little extra rolling and lurching.

There would be, naturally, in the minds of nervous and fearsome passengers, who before had never seen the sea, and who possibly had made up their minds to be wrecked on the first approach of the gale, a great deal of terror and consternation. The bustle and jumping about of the crew in their anxiety to get sail made on the ship; the alarming accents of hoarse, and possibly screaming, words of command, often necessary in hard blowing weather in order to top the voice of the gale; the smashing of hundredweights of steward's crockery not chocked off; and the constant fetchway of cabin furniture—unlashed—would well account for the panic among passengers. However, the captain and his officers were quite masters of the situation, as far as human efforts, skill, and seamanship are concerned. The ship was kept under as much canvas as was proper till the completion of repairs, when, on the starting of the engines, sail was taken in and her head pointed to the westward under steam once more.

Circumstances, however, did not long favor the Anchoria and her commander. The noble efforts of the engineers, highly commendable under such difficulties, proved, after a few hours' trial, to be unavailing. And such failure is neither singular nor astonishing. The wonder is that when a shaft does give way, it can ever again be made serviceable by repairs effected at sea, and in the confined space of a steamer's tunnel. The methods employed, and the tools also, may well be unreliable to enable a so mended shaft to withstand the enormous strains which navigating a heavy ship through a turbulent sea must bring upon it. The thing, however, has been done at sea, and under the most difficult conditions as to tools, space to work in, and weather. Some five years ago, a shaft, measuring 16 in. diameter, gave way, apparently along a welding. The fissure, or break, extend in scarf form, and in length, about thirty inches. The two parts were brought together, and three holes drilled through them, in which were passed three stout bolts, all securely and tightly screwed up. The repairs lasted seven days. Some of the tools and bolts had to be made; and with such repairs, a heavy ship steamed no less than 8,000 miles safely to her destination. The weather was generally fine right through the voyage. The nature and form of the break was possibly favorable to such success in that case, but the result was not a little astonishing to engineering experts.

The Anchoria was about 500 miles from St. John's—her nearest port—when her shaft gave way. She was 12 days under sail, during repairs, and in that time accomplished something like 300 miles, by the assistance alone of her canvas. Thus she averaged about 25 miles a day; and quite as much as could have been expected, in sailing to the westward on that ocean, and at this season of the year. Large steamers carry a very

small spread of canvas in comparison to sailing ships; and in an accident of this sort, with a heavy four-bladed screw hanging to their sterns, they do little or nothing when sailing by the wind and in making way to the westward on the Atlantic. The winds from that quarter are too prevalent, and often too strong, for them to be able to do anything but drift. If her head had been put to the eastward, she would probably have got to Queenstown within 12 days. Rigged as she is, she should have covered not less than 90 or 100 miles a day, sailing eastward. The duty of a ship captain, however, is—under all circumstances, nearly—to get to his destination, or in that direction, if possible. A four-masted steamer, a few years ago, with her shaft broken, and her propeller hanging free, logged as much as 1,600 miles in eight consecutive days under her canvas alone. The Anchoria saw no steamers during her breakdown, and the reason of this would be that she was from 90 to 180 miles north of the mean track from New York to Queenstown.

Possibly some of the same company's steamers from New York to Glasgow were being looked for in that part of the sea; but in any case, if her head had been put to the southward, she must, infallibly, have fallen in with steamers before a week had elapsed. They could have given her assistance or brought on tidings of her condition. The southern track is now so thoroughly well traversed that it is much more advisable to make for it than to hope against hope in picking up one of the few-and-far-between vessels further north. However, in the management of these large steamers, such matters are perfectly understood; and doubtless the captain had very good reasons for doing as he did. Himself and his officers are to be highly complimented on the safe termination of their eventful voyage; and especially in getting the steamer, with 700 souls on board, into a safe harbor at last. The danger of a shaft giving way—the worst possible danger—is that the broken end may go through the ship, as happened a very few years ago, near the equator. In such case, the condition of 700 people, in open boats and rafts, may be better imagined than described. But if the hull of the ship remains intact, it is not a very much more serious question than that of a disabled sailing ship, as long as water and provisions hold out. Whenever an Atlantic steamer is overdue, there is, however, always much anxiety and speculation as to her delay, on account of the numerous and pressing dangers for which that ocean has a notoriety.—*Nautical Magazine.*

HOW TO RIDE A RUSSIAN HORSE.

THE following hints apply chiefly to Russian riding horses, which are a distinct breed from the trotters. These riding horses are very highly trained, and require quite different riding to an English hunter; in fact, any one used only to riding the latter would find it almost impossible to do anything with a Russian horse, for the horse would most likely "rear." An English hunter is guided entirely by the *reins*, but a Russian horse is principally guided by *the rider's legs*, as shown in the accompanying sketches, and as will be explained further on.

PUTTING ON THE BRIDLE.

The bridle must be put on so that the snaffle just touches the corner of the mouth, neither wrinkling the mouth nor hanging below the corner. The curb bit must be the width of one finger above the tusk for a horse, or opposite the hollow in the chin for a mare. The curb may be put a little lower in the mouth if the horse carries his head too high, or it may be put higher if he carries his head too low. The curb chain must allow three fingers to be placed between it and the jaw.

If the horse has a tendency to keep his mouth open, a nose band is put on, tight enough for one finger to pass between it and the nose. The left elbow must be kept close to the side, and all pulling and turning must be done with *the wrist alone.* The stirrups ought to reach just the middle of the boot heel, when the foot is out of the stirrup and the leg hangs straight.

The rider must sit more on the lower part of the back than in English riding, so as to allow the calves of his legs to be put back against the horse without having to lean forward. Ride on the curb alone, holding the reins each side of the third finger of the left hand, the snaffle either lying in the palm of the left hand, or the end given a half turn and the curb reins passed through the loop so formed, or the curb reins may be passed through a slit made expressly in the snaffle reins for this purpose.

If the horse gets too excited, ride him on the curb and snaffle reins, held equally tight, holding the off snaffle rein in the hand. After mounting, press the calves of your legs gradually harder and harder against his sides behind the girths, and pull, gradually, harder and harder, as much as he will allow; then, by loosening the reins *very* slightly, he will stand bending his neck and playing with the bit.

TO START INTO A WALK. (FIG. 1.)

Press harder with the calves, *without* giving him his head. Especially note *never* to give him his head to start into any pace, or for increasing his speed, but always use a pressure of the calves for that purpose. There must always be a slight pressure of both calves during all the following movements, for the horse will never rear if with every harder pull at the reins you give a corresponding squeeze with the calves.

TO TURN TO FACE THE OTHER WAY WHEN STANDING.

A. To pivot on the *hind* legs to the right:

Press the near rein against his neck, and press still harder with your left calf, without taking your right calf away.

B. To pivot on the *fore* legs to the right:

Press the near rein against his neck, and press still harder with your right calf, without taking your left calf away. Note especially that you must not take the calves away, or diminish the pressure of the one which is turning the horse, until he has turned as far as you want him to turn.

TO TURN AND TO CIRCLE ON A WALK TO THE RIGHT.

Press the reins against the left side of his neck, and press the left calf against him during the whole turn; the harder the pressure the shorter the turn (the left turn is the reverse of this). In all turns lean well back and *toward* where you are turning, and use the spur of the leg with which you are turning the horse, if he will not obey the calf.

TO WALK SIDEWAYS.

If with the right side foremost, turn him slightly to the left, then keep the left rein against his neck, and the left leg well back the whole time you want to keep

FIG. 1.—TO START INTO A WALK.

walking so. If you want to change and walk with the left side foremost, bring the left calf forward and the right calf back, pressing the right rein against his neck. Particularly mark, however, this, if the horse goes too slow or backs, you must squeeze harder with both legs. If a horse wants to walk sideways, when you want him to walk straight, press a little harder with the calf on the side to which he turns his hind quarters. If he still persists, take up the snaffle rein on the same side, and pull it as well.

TO START TROTTING FROM STANDING OR WALKING. (FIG. 2.)

Press harder with both calves.

TO TROT SIDEWAYS. (FIG. 3.)

The same as for walking sideways, only give more pressure of the calves, and pull harder. Mark, how-

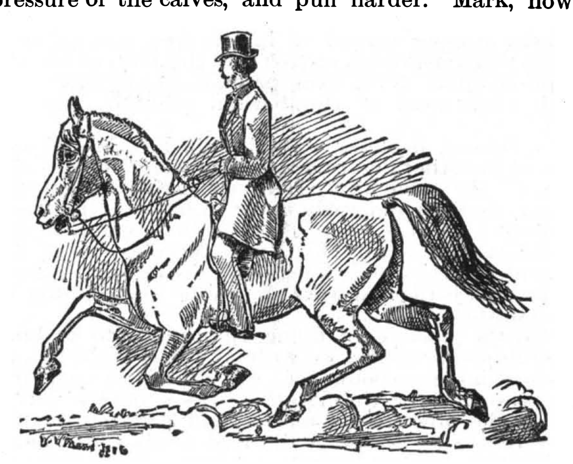


FIG. 2.—TO START TROTTING.

ever, that you must not trot more than a few yards at a time sideways, or the horse may "strike a leg."

TO TURN OR CIRCLE IN A TROT.

The same as for walking.

TO START INTO A CANTER FROM STANDING OR WALKING. (FIG. 4.)

If on the off leg, turn his head a little to the left, and strike him sharply with the left calf (or the spur if he is sluggish).

If on the near leg, reverse this, and note that if a horse starts on the wrong leg, or "mixed," you must stop him instantly and begin again.

TO CHANGE FROM A TROT TO A CANTER.

The same as from walking, except that care must be

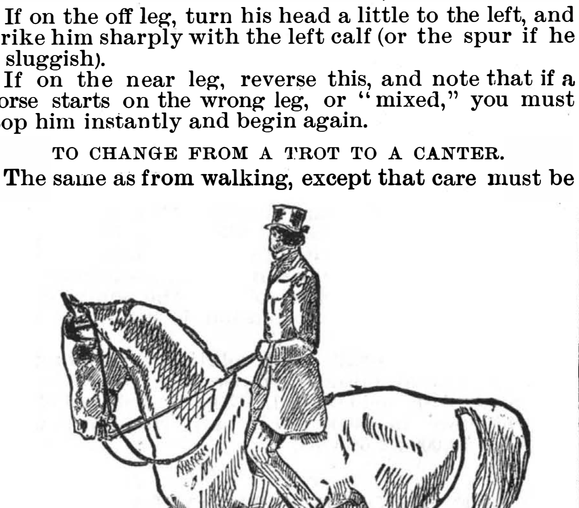


FIG. 3.—TO TROT SIDEWAYS.

taken to lift him into the canter at the moment when the leg he is wanted to lead with is extended *backward.* It must here be especially noted that it is best not to make a horse often change to a canter from a trot, as it makes him apt to break into a canter of himself when trotting; but he can be brought back to a trot by using the calf on the side with which he is leading in the canter.

TO CHANGE LEGS IN THE CANTER.

If the horse is cantering on the off leg, press the near rein against his neck, turning him slightly to the right (because your left leg is still against him); then take the left calf away, and strike him with the right calf or spur. In this case, if he does not change instantly or completely, pull him up to a standstill, and, after a moment, start him, leading with the leg you want. *You must only turn toward the side with which the*

FIG. 4.—STARTING TO CANTER ON THE NEAR LEG.

horse is leading in his canter; if you want to turn the reverse way, you must *first* make him change the leading leg. If he kicks while cantering, sit well back in the saddle, and keep the left hand well up.

TO TURN OR CIRCLE IN A CANTER.

If to the right, press the reins against the left side of his neck, and press the left calf against him during the whole turn—pressing harder if you want to turn shorter, and using the spur if he will not obey the calf. Lean well back, and very much toward where you are turning (as in skating), and do not turn faster than in a very slow canter, and do not turn in a smaller circle than one of fourteen feet (or two lengths) diameter.

TO COME BACK TO A TROT FROM A CANTER.

If the horse is cantering on the off leg, slacken speed and tap him gently with the right calf.

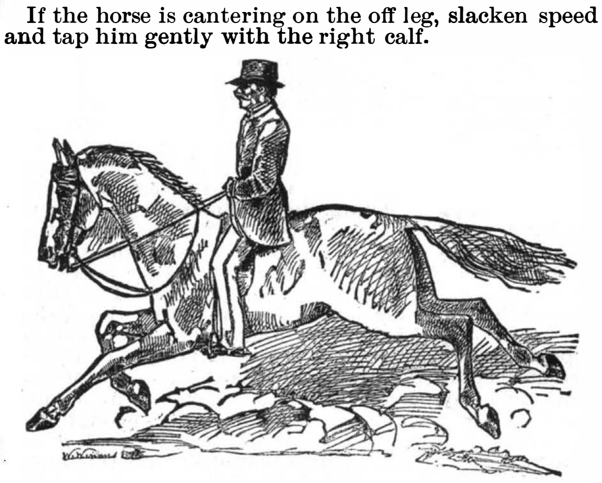


FIG. 5.—TO GALLOP FROM A CANTER.

TO START FULL GALLOP FROM A CANTER. (FIG. 5.)

Strike him with both spurs, and then give him his head a little more.

TO GET BACK INTO A CANTER.

Pull at him, at the same time squeezing him with both the calves.

TO STOP DEAD FROM A GALLOP. (FIG. 6.)

Lean well back, press hard with both calves, and then pull hard.

Some of the preceding remarks may be useful even when riding an English horse. For instance, one of the chief reasons horses slip up in the park is because the riders turn them too fast on a canter, and when they are *leading with the wrong leg* for the direction they are being turned in.

English horses can easily be taught to change in their canter or turning; in fact, most horses will do so by

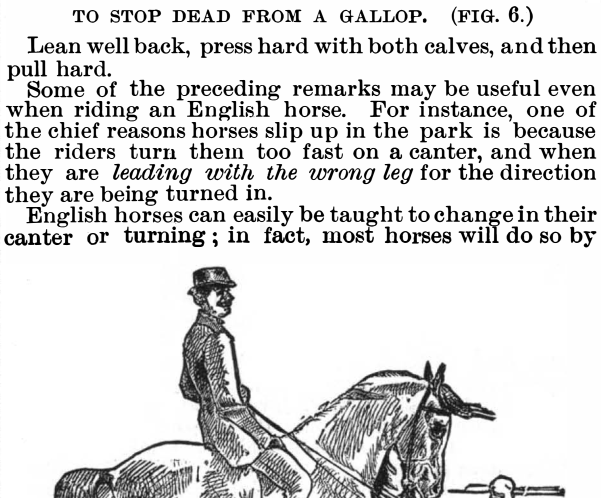


FIG. 6.—TO STOP DEAD FROM A GALLOP.

instinct (polo ponies, for instance, during a game). But many riders *force* their horses to turn on the wrong leg, out of the mistaken idea that a horse should always lead with the off leg in cantering, and never be allowed to change.

The Russian *Cossack* riding horses are trained to go in a snaffle bridle instead of in a curb, and the horse is taught to go with his head up in the air. The reason

for this is that a horse, if he had his head down in a snaffle, could not be turned and stopped quickly enough for military purposes. With his head up, the snaffle is more severe, acting as a gag snaffle.

A Russian horse requires to be gradually taught to stand the rider's rising in the stirrups in trotting, as Russians do not rise when trotting, and the horse does not understand what "rising" means, and is apt to canter at first.—*Walter Winans, in Illustrations.*

THE DISTRIBUTION OF THE MINOR PLANETS.*

By DANIEL KIRKWOOD.

WHOEVER looks at a table of asteroids, arranged in their order of discovery, will find only a perplexing mass of figures. Whether we regard their distance, their inclinations, or the forms of their orbits, the elements of the members are without any obvious connection. Nor is the confusion lessened when the orbits are drawn and presented to the eye. In fact, the crossing and recrossing of more than 260 ellipses of various forms merely increase the entanglement. But can no order be traced in all this complexity? Are there no breaks or vacant spaces within the zone's extreme limits? Has Jupiter's influence been effective in fixing the position and arrangement of the cluster? Such are some of the questions demanding our attention. If "the universe is a book written for man's reading," patient study may resolve the problem contained in these mysterious leaves.

After much thought on the subject, it was announced by the writer a few years since that *those parts of the asteroid zone in which a simple relation of commensurability would obtain between the period of a minor planet and that of Jupiter are distinguished as gaps or chasms, similar to the interval in Saturn's ring.*

The existence of these blanks was predicted in theory before it was recognized as a fact of observation. When the law was first stated, in 1866, but ten asteroids had been found with distances greater than three times that of the earth. The number of such now known is sixty-four. For more than a score of years the progress of discovery has been watched with lively interest, and the one hundred and seventy-six new members of the group have been found moving in harmony with this law of distribution.†

It is the design of the present paper to show: (1) that the fact above stated in regard to these planetary arrangements is a true law of nature; and (2) to indicate its probable explanation.

COMMENSURABILITY OF PERIODS.

When we say that an asteroid's period is commensurable with that of Jupiter, we mean that a certain whole number of the former is equal to another whole number of the latter. For instance, if a minor planet completes two revolutions to Jupiter's one, or five to Jupiter's two, the periods are commensurable. It must be remarked, however, that Jupiter's effectiveness in disturbing the motion of a minor planet depends on the *order* of commensurability. Thus, if the ratio of the less to the greater period is expressed by the fraction $\frac{1}{2}$, where the difference between the numerator and denominator is one, the commensurability is of the first order; $\frac{1}{3}$ is of the second; $\frac{2}{5}$, of the third, etc. The difference between the terms of the ratio indicates the frequency of conjunctions while Jupiter is completing the number of revolutions expressed by the numerator. The distance 3·277, corresponding to the ratio $\frac{1}{2}$, is the only case of the first order in the entire ring; those of the second order, answering to $\frac{1}{3}$ and $\frac{3}{5}$, are 2·50 and 3·70. These orders of commensurability may be thus arranged in a tabular form, the radius of the earth's orbit being the unit of distance:

Order.	Ratio.	Distance.
First	$\frac{1}{2}$	3·277
Second	$\frac{1}{3}$, $\frac{3}{5}$	2·50 3·70
Third	$\frac{2}{5}$, $\frac{4}{7}$, $\frac{5}{8}$	2·82 3·58 3·80
Fourth	$\frac{3}{7}$, $\frac{5}{9}$, $\frac{7}{11}$	2·95 3·51 3·85

Do these parts of the ring present discontinuities? and if so, can they be ascribed to a chance distribution? Let us consider them in order.

I.—THE DISTANCE 3·277.

At this distance, an asteroid's conjunctions with Jupiter would all occur at the same place, and its perturbations would be there repeated at intervals equal to Jupiter's period (11·86 *y*). Now when the asteroids are arranged in the order of their mean distances, this part of the zone presents a wide chasm. The space between 3·216 and 3·375 remains hitherto a perfect blank, while the adjacent portions of equal breadth, interior and exterior, contain fifty-four minor planets. The probability that this distribution is not the result of chance is more than three hundred billions to one.

The breadth of this chasm is one twentieth part of its distance from the sun, or one eleventh part of the breadth of the entire zone.

II.—THE SECOND ORDER OF COMMENSURABILITY—THE DISTANCES 2·50 AND 3·70.

At the former of these distances, an asteroid's period would be one-third of Jupiter's, and at the latter, three-fifths. That part of the zone included between the distances 2·30 and 2·70 contains 107 intervals, exclusive of the maximum at the critical distance 2·50. This gap—between Thetis and Hestia—is not only much greater than any other of this number, but is more than sixteen times greater than their average. The distance 3·70 falls in the wide hiatus interior to the orbit of Ismene.

* Read before the Indiana Academy of Science, Dec. 30, 1886.

† Menippe, No. 188, is placed in one of the gaps by its calculated elements; but the fact that it has not been seen since the year of its discovery, 1878, indicates a probable error in its elements.

III.—CHASMS CORRESPONDING TO THE THIRD ORDER—THE DISTANCES 2·82, 3·58, AND 3·80.

As the order of commensurability becomes less simple, the corresponding breaks in the zone are less distinctly marked. In the present case, conjunctions with Jupiter would occur at angular intervals of one hundred and twenty degrees. The gaps, however, are still easily perceptible. Between the distances 2·753 and 2·803, we find twenty-five minor planets. In the next exterior space of equal breadth, containing the distance 2·82, there is but one. This is No. 188, Menippe, whose elements are still somewhat uncertain. The space between 2·853 and 2·903—that is, the part of equal extent immediately beyond the gap—contains twelve asteroids. The distances 3·58 and 3·80 are in the chasm between Andromache and Ismene.

IV.—THE DISTANCES 2·95, 3·51, AND 3·85, CORRESPONDING TO THE FOURTH ORDER OF COMMENSURABILITY.

The first of these distances is in the interval between Psyche and Kriemhild; the second and third, in that exterior to Andromache.

The nine cases considered are the only ones in which the conjunctions with Jupiter would occur at less than five points of an asteroid's orbit. Higher orders of commensurability may perhaps be neglected. It will be seen, however, that the distances 2·25, 2·70, 3·03, and 3·23, corresponding to the ratios of the fifth order, $\frac{2}{7}$, $\frac{3}{8}$, $\frac{4}{9}$, and $\frac{6}{11}$, still afford traces of Jupiter's influence. The first is in the interval between Augusta and Feronia; the last falls in the same gap with 3·277; and the second and third are in breaks less distinctly marked. It may also be worthy of notice that the rather wide interval between Sappho and Victoria is where ten periods of a minor planet would be equal to three of Jupiter.

The fact of the existence of these gaps in the designated parts of the ring is thus clearly established. But the theory of probability applied in a single instance gives, as we have seen, but one chance in 300,000,000,000 that the distribution is accidental. This improbability is increased many millions of times when we include all the gaps corresponding to simple cases of commensurability. We conclude, therefore, that those discontinuities cannot be referred to a chance arrangement. What, then, is their physical cause? and what has become of the eliminated asteroids?

In any form of the nebular hypothesis the sun's dimensions were formerly much greater than at present. But were a planet's perihelion distance less than the sun's radius, a collision would occur as the moving body approached the focus of its path. If Mercury's orbit, for instance, had its present eccentricity when the radius of the sun was 29,000,000 miles, the planet in perihelion would have passed through the outer strata of the central body. In such case either the planet's fall into the sun or a lessening of its mean distance would have been a necessary consequence. Again, the perihelion distance of Æthra is but 1·587. This asteroid's orbit, therefore, could not have had its present form and dimensions when the radius of the solar nebula was equal to the present aphelion distance of Mars (1·665). We thus see that in the formation of the system the eccentricity of an asteroid's orbit could not increase beyond a moderate limit *without the planet's return to the solar mass.* But the gaps are in those portions of the ring in which Jupiter would produce extraordinary perturbations. In those positions the disturbed orbits of original asteroids would attain considerable eccentricity, so that the matter moving in them might, at perihelion, be brought in contact with the equatorial parts of the central body. The formation of chasms by the elimination of minor planets with very eccentric orbits would be an obvious result.

The law stated in the beginning, of this paper has been shown to be true. A physical cause of the phenomena, adequate both in mode and measure, has also been assigned. This explanation seems entirely satisfactory, and no other, it is believed, has ever been suggested. As it assumes the development of the solar system by the contraction of a nebulous mass, it sustains an obvious relation to the hypotheses of Faye, Proctor, Herschel, and Laplace.

WASHINGTON ANTHROPOLOGICAL SOCIETY, MEETING OF NOVEMBER 16, 1886.

On a Prehistoric Hearth under the Quaternary Deposits in Western New York. By G. K. Gilbert.

The speaker described the finding of the remains of a wood fire in the bottom of a well through the drift deposits near Gaines, a few miles south of Lake Ontario. The evidence in the matter rests almost entirely on the statements of a Mr. Tomlinson, a well known and respected resident of the place, and who, personally, made the find upon his own farm. It was twenty years ago that the discovery was made, but Mr. T. has stated that his memory of all the essential details was very clear, and the speaker had every personal reason for believing the statements. The story is briefly that in sinking a well through seventeen feet of gravel and clay, they found lying upon the rock at its bottom three large stones, partly inclosing a small space in which were about a dozen charred sticks, undoubtedly the remains of a fire started by human hands. Mr. T. gave some of these remains to neighbors, who still remember the matter, and the remainder he kept himself. In time, however, they have been lost, and the endeavor to find them did not meet with success.

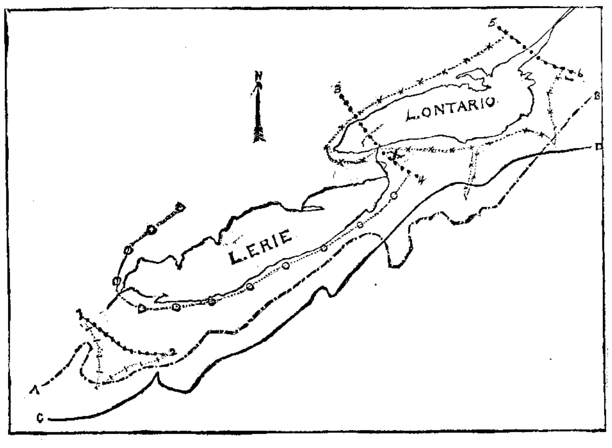
The speaker then discussed at length the character of the beds under which the remains were found, and their geologic age, illustrating his statements by a map, of which a small copy is here reproduced.

The line A B shows the approximate southern limit of the lake drainage, and C D the approximate southeastern extension of the second glacier, which, it will be noted, extends across the drainage line for a considerable distance. When the front of the glacier began to retreat, successive lake basins were formed, extending toward the drainage line and discharging at the lowest point in the divide. When the front of the glacier had retreated to the line 1-2, a lake extended over the area shown by the fine dotted line bearing small cross lines, and discharged toward the Ohio, near what is now the city of Fort Wayne. When the ice front had retreated to the line, 3 4, the lake covered the area in part inclosed by the fine dotted line bearing the small circles. It was on the eastern shore of this lake that this ancient fire was built, and by its shore wash that it was so gently covered as not to be disturbed during the process.

By further retreat of the glacier toward 5-6, a lower outlet was exposed in the valley of the Mohawk, and the surface of the glacial lake again fell—the Lake Erie portion to the level of the escarpment of Niagara limestone which still dams it back, and the Lake Ontario portion to a somewhat lower level. Further retreat of the icy dam to 5-6, and beyond, opened the St. Lawrence channel, and the present drainage was established.

From this explanation the comparative age of the hearth and its remains is indicated. It was near the end of the second glacial period, and at the time of separation of Lake Ontario from Lake Erie. At about this time, also, the Niagara River began its work of cutting through the escarpment of Niagara limestone, and at which it has been engaged ever since. Its rate of progress having recently been approximately determined, we are able to estimate the number of years as about 7,000 since the lakes were separated and the gorge and falls begun. This estimate is based on comparisons of recent survey by the U. S. Geological Survey with those made by the New York survey forty years ago, and is open to some qualifications. In the first place, it is possible that some of the gorge was cut before the glacial period; then it has been found that the hardest stratum through which the river has to cut thins somewhat to the eastward, and thus offered less resistance to wear at an earlier date in the history of the gorge; and then, again, the possibility is presented of the volume of water having been vastly greater toward the close of the glacial period, and it is known that the erosive power of water increases very rapidly with increase of volume. These qualifications tend to reduce the time estimate; but on the other hand, evidence has been found that at one time the other lakes above Erie emptied by another means, and if this was so for any great length of time after the birth of the Niagara, it would tend to very greatly increase the time.

In the discussion following this paper, Mr. Murdock, of the Point Barrow Station, gave an account of the finding of a prehistoric relic under somewhat similar circumstances. Their station was near the extreme northwest corner of this continent, on a beach ridge a few yards from the Arctic Sea. This ridge was nine or ten yards in height, and extended along the coast for some distance. In making an excavation for an earth thermometer, they penetrated a one foot layer of turf which capped the ridge, and then frozen gravel and earth to a depth of twenty odd feet, where an Eskimo snow goggle was found embedded in the frozen earth. The goggle was identical with those now in use, and consists of a piece of bone covering the eyes and bridging the nose, with small slits to admit a very limited amount of light and protect the eyes from snow blindness. The specimen found had strings of braided sinew attached, but these were broken in removing them from the hard matrix. The speaker believed that the beds inclosing and covering this relic were the results of beach wash. The Eskimos of the region have a tradition that people used to live at the locality of the find, and a few remains of houses are found in the vicinity.



Map of the Ontario-Erie Lake Basins, showing their Quaternary History. The Prehistoric Hearth was found at *x*.

The next paper was an informal one by Mr. W. J. McGee, on the finding of a spear head in the Quaternary beds of Nevada.

The speaker described the geologic features of the Walker River canon, in the lacustrine deposits in which the find was made. These deposits are those of the fossil Lake Lahontan, and were deposited in the old canon during the Quaternary period. Since then the river has cut a new canon through them, and they are now finely exposed. Beginning above, the beds consist of silt and loose materials for several feet, then comes a layer of calcareous tufa lying upon 20 to 30 feet of white marl, containing remains of extinct mammalia, and resting uncomformably upon a somewhat similar series of beds of earlier date. It was in the white marl of the upper beds that the implement was found. The speaker described in detail the conditions under which the find was made. He was alone at the time, and far distant from camp or party; he had been carefully examining the face of the marl talus as he rode along, and was searching for occasional bone remains. At one point, twenty-six feet below the surface, he noticed a small projecting point which looked as if it was caused by a bone. Picking off some of the surface, he at once recognized the object to be a product of man's handicraft; and appreciating the importance of the find and the necessity of a very thorough study of all the circumstances connected with it, framed some working hypotheses before removing the implement. At first it appeared probable that it was embedded in a superficial coating of the slime which is often washed over the surface of this loose marl. This was at once disproved by examination. Other possibilities were suggested, such as its having fallen into its position down a fissure or been shoved into the face of the cliff by man;

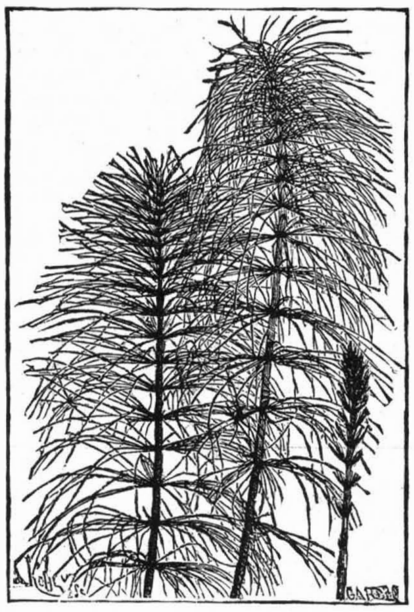
but these were all found to be, if not impossible, extremely improbable, and the speaker had concluded that it was deposited with the marl. Extensive stratigraphic studies have been made of these lacustrine deposits by King, Russell, and Gilbert, and there can be no doubt but that these beds and the flint were deposited toward the close of the glacial period, and about at the same time as those covering the hearth described by Mr. Gilbert. The implement was a spear head 3½ inches in length, finely made and well preserved.

In the discussion which followed this paper, several members called attention to the great value of the find from the fact that it was made by a well trained observer, who appreciated the importance of his discovery before destroying the evidence, and then carefully studied every detail connected with it.

THE GREAT HORSE TAIL.

(EQUISETUM TELMATEIA.)

A NATIVE plant of great beauty, highly desirable to naturalize in any moist spot where its free-rooting nature would not endanger other plants. Nothing could better adorn a fairly large space of wet ground where its graceful plumes, 4 feet to 5 feet high and of



THE GREAT HORSE TAIL (EQUISETUM TELMATEIA).

brilliant green color, could be seen from a sufficient distance as well as close at hand. It may be called a most important landscape plant.—*The Garden.*

AN OPEN AIR SILO.

MR. EDMUND CREIGHTON, one of our correspondents, now residing in Germany, has prepared for the *Country Gentleman* the following abstract from an article in the *Hannoverische Land und Forstwirthschaftliche Zeitung*, Hanover, Sept. 22, 1886:

The most ancient method of preserving green fodder was to keep the same air tight, and make the drying process as short as possible, so as to avoid to the utmost the decomposition and bleaching attendant on dew and rain.

But this way of preparing hay involves a great amount of hand labor, being more or less expensive, according to the state of the weather. To be quite independent of these atmospheric influences, one makes use of the silo; but, although the results are very favorable, the cost of the silo is too great to allow the small farmers to make use of it. But ensilage affords such a good winter fodder for cattle, that a cheaper method would, we doubt not, prove a great boon to those whose means do not allow them to build silos.

To supply this want, both Reynolds and Johnson tried very successfully a press system in the open air; Reynolds by means of chains and cranks, giving a pressure of 300 to 1,000 kilog. to the square meter, Johnson, by cording the stack with galvanized netting, giving a pressure of 75 kg. to the square foot.

Although these two systems are extremely simple, and the work of pressing the hay can be done by one man, yet they have their various disadvantages. In the first place, the chains, ropes, etc., require to be fastened solidly in the ground. Then, of course, one cannot put them on any place one likes, and so cannot reduce the transportation as much as required; and, secondly, they are still too expensive to be owned by all farmers.

The following method therefore surpasses the above, by being simpler, cheaper, and more practical; having also the advantage of easy transport.

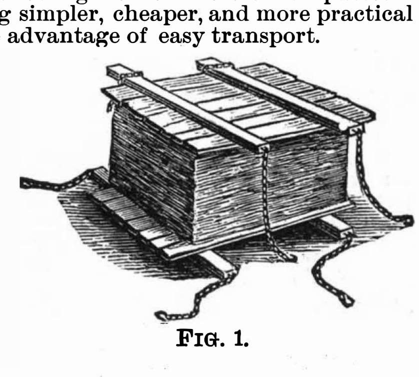


FIG. 1.

Mr. A. Cochard, president of the Agricultural Association of Montmedy, is the inventor of this system.

One puts on the desired site two beams of about 4 meters in length, so as to lie about 2 meters apart, and parallel. Chains of 1 m. long are attached to each end of these beams, and having a hook fastened to their last links. On these two beams a floor is made by placing old railway ties (if obtainable) crosswise on them, and on the flooring the fodder is placed, which in Fig. 1 represents a four-cornered stack, containing about 45 cubic meters. Then on the top of the stack is placed a roof of old ties similar to the flooring. On this roofing are placed a couple of beams. These latter have at each end chains about 3 meters long, without any hooks.

To obtain the required pressure, which is unavoidably necessary to preserve green fodder, one uses a lever (Fig. 2), *i. e.*, a simple round iron bar, about 3 centimeters thick and 4 meters long. This bar has 6 holes, about 10 centimeters apart from each other, in which are fastened strong, short chains of about 15 centimeters in length, each of them having a little hook attached to them. The chains (Fig. 2) are arranged so

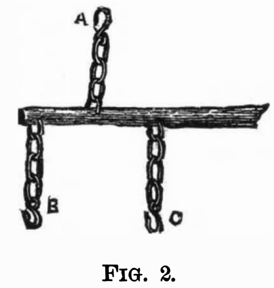


FIG. 2.

that the middle chain works in an opposite direction to the other two. The hand labor is very simple, one man alone being needed, but it is preferable to have two, thus obtaining a greater and more equal pressure.

The man fastens the middle hook, A, in one of the links of the lower beam chain, and ditto the hook, C, in a link of the upper beam chain (Fig. 3, left), and the hook, B, can then be put about 10 centimeters higher than the hook, C, in another link of the chain; the position of the lever is now as represented in Fig. 3, right. Then the lever is now raised, upward, to even 10 centimeters more; the man then fastens the hook, C, higher up, and continues this till the lever can no longer be worked. Finally he fastens the lower beam

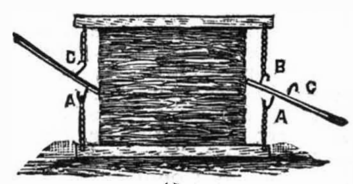


FIG. 3.

chain hook on the upper beam chain. If, as I have described, there is only one man, this occasions an unequal sinking of the stack; thus the men work at different ends of the same beam, each having, of course, a lever, and keeping the pressure equal.

At first one must press the stack every day, so as to keep up with its gradual sinking; after about ten days the pressing is over.

Fodder preserved in this manner will keep for years, and—excepting a layer of about 10 centimeters thick at the side—gives an excellent quality of ensilage. The sheep and cows ate it greedily.

For use, one takes up one or two of the sleepers, and with a sharp hay knife cuts enough long, vertical strips, as wanted; then hook on the chains as before. The temperature of the inside of the stack is about 70° C., and remains as high till the fermentation begins, then it sinks to about 50° or 40° C., at which it keeps the same for a long time. This high temperature destroys the fermentation powers, and hay so preserved is one of the sweetest ensilages known.

	Green Fodder preserved as above—per cent.	Ensilage from ordinary silo—per cent.
Water	64·00	84·70
Fat	1·00	0·75
Bodies containing nitrogen	4·68	2·06
Bodies not containing nitrogen	4·02	2·00
Raw fibers	7·20	3·32
Ashes	4·00	1·96
Bodies not especially examined	15·10	5·22
	As Dry Fodder—per cent.	As Dry Fodder—per cent.
Fat	4·92	2·80
Bodies containing nitrogen	13·45	13·06
Bodies not containing nitrogen	13·05	11·20
Raw fibers	21·70	20·00

By comparing the results of the respective analyses, one sees that the hay preserved in open air is of much better quality than that preserved in silos; added to which, the open air silo is much cheaper and much simpler than the ordinary silo.

If one arm of the lever is 3 meters long, and the other arm is 10 centimeters, so the two working powers act on each other as 1 to 30, then the pressure brought by one workman is (his weight being about 70 kilog.) 70 times 30 = 2,100 kilog.; the total pressure on the whole stack is then 4 times 2,100 = 8,400 kilog. If the surface of the stack is 10 square meters (4 meters long by 2·50 meters broad), so is the pressure on the square meter one-tenth of 8,400=840 kg.; and when two workmen do the work, so is the total weight per square meter 1,680 kilog.

INSECTS ON FRUIT TREES.

ALL fruit trees infested with insects in summer will be sure to retain many of them throughout the winter, as, although some of them may fall off with the leaves, those on the wood are not so easily detached, and in spring begin their depredations anew. Thrips and greenfly are foliage pests, but scale and American blight cling to the wood, and it is these two that ought to be exterminated in the winter time, when the foliage is off the branches. Scale and American blight are not easily destroyed. Frost and severe weather have no effect on them, and, as a rule, they increase in numbers spring after spring, until the tree suffers greatly in health. Those who know the advantages of keeping their trees free from insects will be only too glad to adopt any measure which will act either as a prevention or a cure. Of all the insecticides we have tried for killing American blight and scale, we have found none to equal petroleum. No fruit tree insect can survive a good dose of it properly applied. American blight is absolutely consumed by it, and scale drops off in quantities. The best way of using petroleum is to add one pint of it to six gallons of hot water and a piece of washing soda about the size of an egg; stir it all well up, and then syringe the trees with it. In applying it, many are inclined to syringe it as forcibly as they can, but that is useless, as hard syringing will never kill insects, while a great deal of the mixture is lost in the operation. If it is syringed gently, just to moisten the branches, it is equally, or indeed more, effective than when applied with force. In the case of wall trees, it may be syringed on them in such a way as to moisten the wall and damp the joints between the stones or bricks, as many insects lurk in such spots. The petroleum may be allowed to remain on the trees five minutes; it should then be syringed off with water heated to 90°. One dressing of this kind is quite sufficient to clean the worst affected trees, and with such a simple remedy at hand no one ought to allow their trees to be infested with insects of any kind.—*Cambrian, in The Garden.*

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