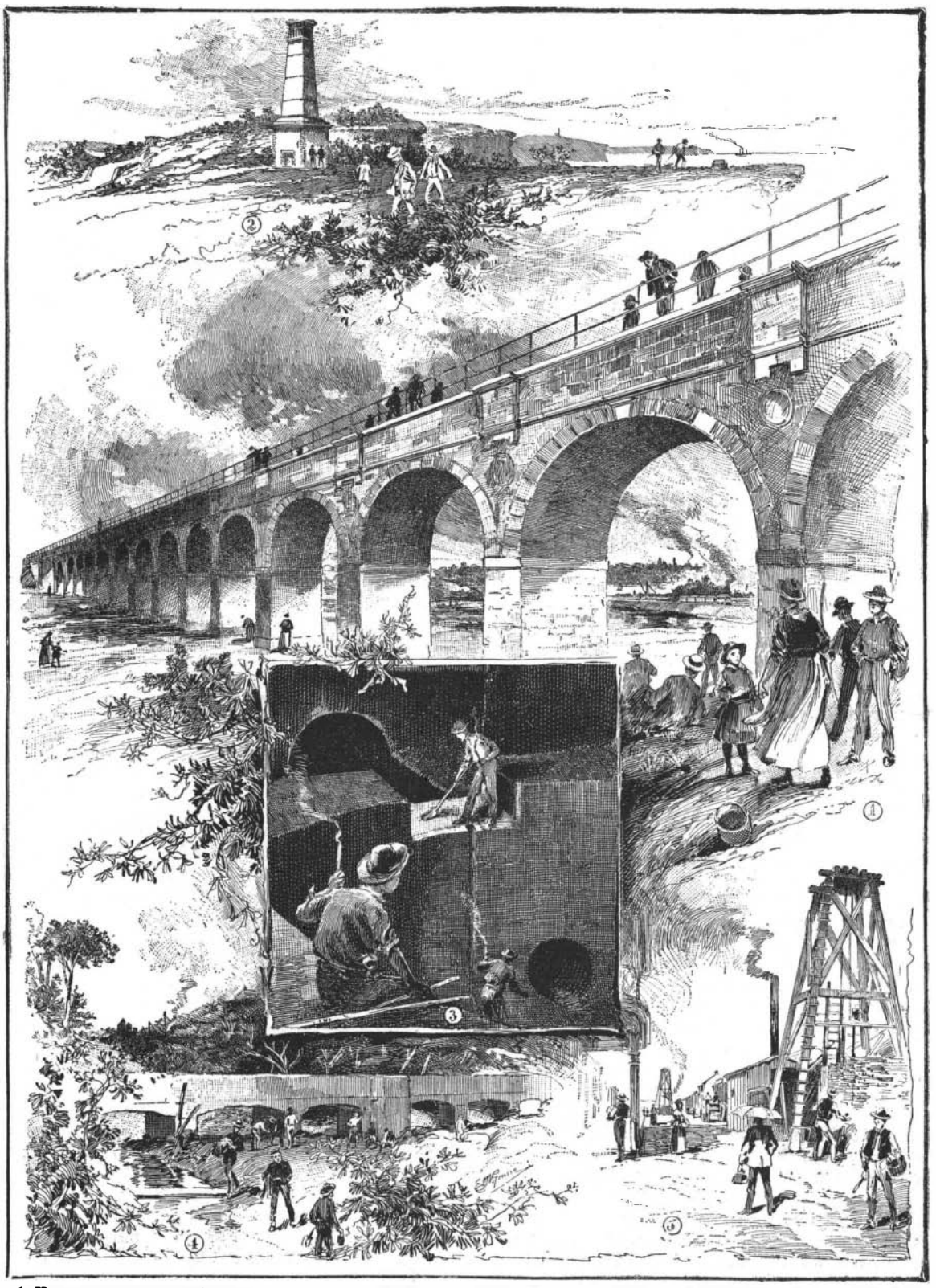
THE SEWERAGE SYSTEMS OF SYDNEY, AUSTRALIA.

The northern main outfall sewer starts from the junction of Newtown and Parramatta Roads, just at the city boundary, and runs thence along George Street west to the Benevolent Asylum, then through Belmore Park across to the junction of College and Liverpool Streets. From here it continues along Liverpool Street for some distance, thence across Lacrozea Valley, and on through the hill to Edgecliff Road. After coming through this it crosses the low sandy area at the head of Rose Bay, once more plunges into the hillside opposite, and finally reaches the ocean, about half a mile north of Ben Buckler. The total length of the whole is 5 m. 2,700 ft. The sewer is oviform throughout, and of varying dimensions. At the upper end it is 5 ft. by 4 ft., and gradually increases in size as it progresses, till it reaches the last mile, when it becomes 8 ft. 6 in. by 7 ft. 6 in. The materials used in the work were the most carefully combined bluestone concrete for the invert, or lower part of the sewer, and brickwork of specially made bricks for the soffit, or arch above. This brickwork is packed solid to the rock throughout the tunnels with sandstone concrete. From Oxford Street to the outlet the sewer is rendered inside with Portland cement mortar to three-fourths of its height, and the brickwork carefully pointed. Along the rest of its length it is rendered all round. In the course of this work many considerable difficulties had to be met, but all were successfully overcome. The greater part of the tunneling was done in sandstone rock, but some tunnels had also to be driven through wet shale and water-charged sand. In addition, there were a couple of stretches of low-lying, sandy country to be passed over. Over these last the sewer was carried on massive concrete foundations, and, when completed, was covered by an embankment. In going through the wet rock all sorts of precautions were taken to keep the water away from the works in progress, subducts or underneath drains being the means most frequently employed. But it was the water-charged sand that gave the most trouble. It occurred on the last contract, that for the 90 chains nearest the outlet, and had to be got through partly by open cutting and partly by tunneling. Of the first the depth was never less than 30 ft., while all possible expedients had to be resorted to to keep the water down. Nine centrifugal pumps were constantly at work, pumping wells were sunk at various spots, and a subduct was laid all along the center of the sewer trench.



1. View of aqueduct across Johnstone Creek. 2. Outlet of the Bondi main sewer at Ben Buckler, with ventilating shaft. 3. Interior of outlet chamber. 4. Waverley and Woollahra branch sewer over Double Bay Flat. 5. View of sewer shafts in Dennison Street, Waverley.

SKETCHES OF THE SEWERAGE SYSTEMS OF SYDNEY, N. S. W.

The most interesting feature of the whole northern outfall sewer is certainly the outlet, which is absolutely unique of its kind, it being the result of the observation combined with the engineering ingenuity and skill of the departmental engineers. The sewer discharges into the ocean through the cliffs, but it is not to be supposed that it simply runs straight to the face of the cliff, and there abruptly ends. During southerly, southeasterly, or easterly gales, the waves on the coast attain enormous proportions, and strike the coastline and the cliffs with extraordinary force. No person who has not actually witnessed it can form an idea of the magnitude of the waves which roll on this coast, or of the overwhelming force with which they strike the cliffs in heavy storms. It was to be feared that if the outlet were fixed at so low a level as to be within reach of their full force, so large a body of water would be thrown into it during storms as to seriously interfere with the discharge of the sewer. The Board therefore suggested the formation within the sewer at a convenient distance of an expanding basin, where the waves would be partly broken and dispersed.

The sewer proper was brought to a conclusion 200 ft. from the cliff, and there it discharged into a chamber 36 ft. long, 24 ft. wide, and 21 ft. high. In the middle of this chamber was built a massive weir, concave on the seaward face, and having a projecting cutwater to support it, and facing up stream. In the weir hall, which extends from the cutwater to either side of the chamber, are two 4 ft. circular openings, at the level of the floor. The chamber beyond ends in two outlet tunnels (also 4 ft. circular), which penetrate to the face of the cliff in different directions, making an angle of 31° with one another. The illustration shows the interior arrangement of the chamber, access to which is obtained by means of a shaft 12 ft. by 5 ft., and 145 ft. high. The top of this shaft is protected by a brick inclosure (represented in illustration No. 2), which is some 56 ft. high, and forms quite a landmark on the cliff. The working of the chamber is shortly thus: The sewage enters in on an ogeré (or S shaped) fall of 3½ ft., and meeting the cutwater, is divided by it into two streams, which run round its sides, pass through the openings in the weir wall, and then find their way to the sea by the tunnels. Whenever the sea is high, the waves rush up one or other of these tunnels, and simply expend all their force on the concave portion of the weir, which sends them hurrying back again along with the stream of sewage, which they thus do not interrupt at all. Even should two waves rush up, one through each outlet, at the same time, no harm would be done, as the water would then merely be thrown up into the inner part of the chamber, whence it would run back at once. Of course, it is necessary that this part of the work should be constructed as strongly as possible, seeing what it has to withstand, and great care has been taken that it should be. Bluestone masonry and bluestone concrete alone have been used for all within the chamber. The shaft, which merely leads to it, is lined with brick packed solid to the rock with concrete. Every possible contingency has also been provided against. The highly improbable risk of the four-foot openings in the weir wall becoming choked with rubbish has even been guarded against by leaving ample space for the sewage to flow over the wall before it could do any harm to the main sewer, while from an overhead platform within the chamber any obstruction can be removed by grappling. There are also grooves into which stop boards may be lowered at any time, and the flow of sewage shut off from any channel. This novel and interesting chamber, together with its accessories, has always worked splendidly and seems an unqualified success—as it ought to be.

The probability that this main sewer would at some future time be extended through the Glebe and Balmain was foreseen when the northern scheme was proposed, and allowance was made for such an extension. Consequently when, in 1888, a scheme was drawn up for the drainage of the western suburbs, the provision thus made was utilized, and it was determined to continue the northern main through the Glebe, part of Leichhardt, and into Balmain. The total area that will be drained by this extension is some 1,640 acres, and it will be about 4 miles 520 yards long. The route decided upon is from the junction of the Newtown and Parramatta Roads through the Glebe, across Johnstone's Creek to Piper Street, Leichhardt, along which it continues to White's Creek. After crossing this it goes on through the Brenan Estate, entering Balmain at Foucart Street. Thence it proceeds to and along Darling Street, near the end of which it finally stops. The work is in tunnel practically all the way, except where the creeks have to be crossed. At Johnstone's Creek the flat on either side is to be traversed by the sewer on brick and concrete arches of 27 ft. 8 in. span, which, in turn, are supported on sandstone masonry and concrete piers. Immediately over the creek will be a lattice girder bridge, 42 ft. long, over which wrought iron piping, of similar diameter, will replace the brick and concrete of the former part of the sewer. The illustration reproduces the design approved for the construction of this aqueduct. The work at White's Creek also will be similar to this. In size the sewer is 5 ft. by 4 ft., and oviform in shape at its junction with the outfall, but it gradually diminishes till, at the intersection of Darling and Ann Streets, Balmain, near its head, it is only 4 ft. 2 in. by 2 ft. 6 in. North of this point it consists of 15 in. and 12 in. pipes. Of the whole area from which this main sewer is to receive the drainage, about one-third is too low to be gravitated to it; consequently, some method will have to be adopted to raise its sewage. The cost of this work has been estimated at £75,518. Operations have already been begun on this extension, November, 1890; and so vigorously have they been pushed on, that already the main sewer has been finished as far as Johnstone's Creek.

Connected with this extension of the main sewer there are to be altogether twelve sub-mains or branches, in all a length of 5 m. 513 yds., the cost of which has been estimated at £70,376. Another one also of some importance is being constructed now, but nearer the outlet end. It is called the Waverley and Woollahra branch intercepting sewer, and is nearly a

mile long. It joins the outfall at Double Bay Valley, over which it is carried on piers with concrete arches, and covered by an embankment. The illustration shows the appearance of this part of the sewer before the embankment was made over it. On the opposite side it enters the hill, and goes through it at a very great depth, some of the shafts sunk being over 200 ft. deep, and at them work is being vigorously carried on. Of course, no hand winding gear would be suitable for shafts like these. So above them tower huge tripods, known as poppet heads, and all the hauling is done by a steam engine housed close by. Besides this, authority has been given for the construction of other branches, and more will follow when funds are available. Needless to say, provision has been made all along the line for the entrance of as many as can ever be required. The main outfall also intercepts a good many old sewers directly, and still more are being turned into it by the Water and Sewerage Board, whose shafts may be seen all about in the city streets.

Such in its main features is the first system of the Sydney sewerage scheme, and it cannot be denied that it is very good. Nor can any doubts be thrown on its practical utility. All such are triumphantly answered by the fact that the main outfall from Newtown Road has been in use nearly four years, during the whole of which time it has worked splendidly and been most successful. As regards cost, the sum total spent on the northern outfall sewer has been £419,528, and it is estimated that before the northern system is complete £1,480,600 ($7,403,000) will have been got through. Though these sums sound large, what are they against the saving of life, the saving of health, and the saving of wealth which has been brought about by these works? The very shrinkage in the metropolitan death rate is well worth the money, and it is undisputed that for it the Northern Sewerage System is in a great measure responsible.—*The Illustrated Sydney News.*

How Pottery is Made.

Among the large establishments visited by the members of the American Institute of Mining Engineers at their recent Baltimore session was the Chesapeake potteries, near Baltimore, Md., and the visit is thus described by a correspondent in *Engineering:*

In 1852, before such goods were made in this country, it cost with the tariff at 24 per cent $95 to import an assorted package of ordinary white ware. Now since the manufacture of these goods here and the competition thus brought about, with a tariff of 55 per cent, the same quantity of goods of superior quality costs the consumer $46. Notwithstanding this great reduction in the cost of the goods, the employe in the United States pottery has received more than double the wages paid the English operative for the same work, and more than three times the wages paid to the German workman for like service—he has been able to live comfortably, educate his children, and if reasonably provident, lay aside something for buying a home.

It has been the aim also of those interested in these matters to start a school of design and decoration. A series of prizes were established for designs, and were open to all students in recognized art schools, and the points of award were in excellence of form, adaptation to household use, merit of relief ornamentation, and its suitability to the form. Excellence in color decoration, and its adaptation to form and strength, and originality of the designs forming the set. A plan for a school of pottery was considered in January, 1891, and Mr. D. F. Haynes, one of the proprietors of this pottery, was the chairman of the committee, and judging from his energy and character, your correspondent is of the opinion he will carry this matter to a successful issue. The Pennsylvania Museum of Philadelphia has already taken the initiative, and their liberal offer has been accepted by the committee. This pottery was a great surprise to all of the party, and the work is of a high character in design.

These potteries are located near the clay fields of Maryland, and are also on the deep-water navigation of Chesapeake Bay. The ware is divided into four grades. The first, called C C, is hard and cheap. The second, called white granite, is a finer quality. The third is called semi-porcelain, and resembles French china in color. The fourth is the china or porcelain, and is produced with great care, and requires the most thorough supervision to bring it to a state of perfection, especially in the firing.

The materials for the four grades are prepared similarly, although of course in each instance by varying the mixtures. The substance is put into a tank with revolving arms, and thoroughly mixed with water, then it is forced into a press lined with canvas bags, and the water strained off, leaving a plastic mass called "clay," although composed mostly of flint and feldspar. It now goes on a "jig," which is a rapidly revolving disk of metal, and takes the form of a saucer, plate, or some other flat object, the workman making the most marvelous changes in form by pressing a tool against the rapidly revolving mass. Such pieces as require moulding are made in two parts in the mould, and are then joined together, the seams being covered with a roll of clay which is worked off smoothly, and the mould set aside until, by the absorption of water from the piece by the plaster of the mould, and the drying of the clay from the inside, the piece has so hardened and contracted as to be easily and safely removed; then the handle, which has been made in another mould, is fitted to the body and joined fast by a slip made from clay. The whole is smoothed off, finished, and, bearing the exact impress of the mould in which it was formed, it is placed in the "green room" to dry. Careful handwork is required in all this manipulation, for, plastic as is the clay, it has rights that must be respected, and it cannot be forced too far. With all the care used, many pieces are "marred in the hands of the potter."

The dexterity displayed by the workmen is something astonishing, and it was often a question with the visitor as to what was to be the final shape of the clay. The clay now goes to the kilns, which may be described as follows: They are solidly built of red brick lined with firebrick, and are about 16 feet in diameter inside, and about 16 feet high inside to a crown or roof, above which the kiln rises, tapering in form to a sufficient height to give draught to the fires. Around the base are the fire chambers, eight or ten in number, above which are openings directly into the kiln, and from which lead flues under the floor of the kiln to the center. The kiln in which the ware receives its first fire is called the biscuit kiln. To protect the ware now prepared for firing, which is ready to fall in pieces at a careless touch, boxes made of fireclay called "saggars" are used; these are made of all shapes to suit the ware, high, low, oval, and round, the sides being about one inch in thickness. One of these filled with ware is placed on the bottom of the kiln, with a row of soft clay around the top; another saggar of the same form, likewise filled, is placed on it, and the operation repeated until the tier or "bung" reaches the top of the kiln, other "bungs" are placed close to it, and this is kept up until the kiln is filled, then the door is bricked up and plastered over, the fires are lighted and the work of burning begins.

The heat is increased from a gentle one to about 3,000° F., and this is kept up until all the materials are thoroughly fused and solidified, probably occupying two days and nights. The fire is drawn and cold air carefully excluded. In three days the cooling process is finished. The broken pieces are collected and the good work is dipped in a tub filled with glaze and taken to the kiln for a second firing. This kiln and the saggars used are similar to those used for the biscuit firing, but still greater care is required in placing the ware, for if two pieces touch when the glaze melts in firing, they will be cemented fast to each other. Hollow pieces can be placed upon the bottom of the saggars, which have been sprinkled with small bits of flint, the size of shot, to keep the ware from fastening to the saggar; but plates and flat pieces must be supported underneath by pins, with triangular points made of clay, which are inserted in holes pierced in the sides of the saggar, and they are thus carried one above another while being fired. The firing of these kilns is accomplished in about twenty-four hours, and after cooling the kiln is opened and the wares are ready for the decorating department or to be placed in the bins of the glost wareroom. With all the care the average pottery employe seems to be capable of, the frequent breakage of valuable pieces is trying to delicate nerves, and the disasters of a day will often furnish "potsherds" sufficient for a thousand afflicted Jobs. The final process now comes, viz., the decoration. The design is engraved on a copper plate, mineral colors that will stand firing are mixed with a specially prepared oil, and a print is taken from the plate on a sheet of tissue paper; this is laid in proper position upon the piece of ware to be decorated and rubbed with a flannel until it adheres firmly. After a few hours the paper is removed and the perfect print remains on the ware. This is afterward touched up with color by the women employed, their skill and knowledge having much to do with the character of the decoration produced, but no skill can compensate for the lack of a good design, or make a poor drawing anything but commonplace. Tints covering the ware, or a good part of it, are sometimes used. They are applied by first covering the piece with a thin coat of oil, upon which the color in a fine powder is dusted; when the tint has been fired, a print can be applied on it and excellent effects secured. The application of gold either in the form that fires bright without burnishing, or the preparation that requires after firing to be scoured or burnished, is made with a thin brush in same manner as color is applied.

Simple as the processes used in decoration seem to be, the field for the exercise of a refined taste in their application is boundless. The creation of good designs, the adaptation of decoration to form, the thousand combinations of color, all these deeply interest and draw forth the most earnest efforts of those who make a serious study of pottery decoration. The enamel kiln, in which the decoration is fired on the ware, is constructed with flues surrounding it, so that the fire cannot come in direct contact with the ware, and, therefore, only fireclay bats or shelves are required to place the ware upon in place of the sealed saggars used in the biscuit and glost kilns. From six to ten hours firing is needed to give the decorations permanency, when the ware is removed from the kiln, examined and wrapped for shipment.

Baltimore has five potteries and 750 employes in them. The coming exhibition at Chicago will show what wonderful advance has been made in this industry. Mr. Haynes, with great forethought, had provided souvenir plates specially decorated for the occasion, and having pictures illustrating extracts from Shakespeare.

Stereotyping.

The operation of stereotyping consists of making a mould or matrix in paper or other substance from a type form and casting therefrom a plate which may be printed from in place of the type. The type is surrounded with type-high clumps and locked up. After being carefully cleaned and brushed over with an oiled brush, it is ready for moulding. The mould is made by using a preparation of sheets of paper pasted together, called flong. Flong is made by taking a sheet of blotting paper and pasting one side of it with a specially prepared paste, hereafter described, and placing over it a sheet of tissue paper, then pasting again and putting on another sheet of tissue; next, the other side of the blotting receives two pasted tissues in the same way. Before being used a sheet of tissue is pasted on one side and a sheet of blotting on the other. The tissue side, being the face side, is dusted over with French chalk, to prevent the mould sticking and to help the metal to run.

To make the mould, the flong is placed face (or tissue side) downward on the form and beaten into the type with a large flat brush. When sufficiently beaten, the whites and hollows need packing. Strips of cardboard —about eight or ten sheet board is the proper thickness—are cut to fit the various places, and the whole is covered up with a pasted sheet of stout brown paper. The form, with the mould upon it, is then placed in the drying box, a piece of press blanket put over it, and pressure applied. The drying box is something after the form of a copying press, with an atmospheric gas burner under to give heat. After stopping in the drying box about fifteen minutes the pressure is released, the blanket removed, and the mould allowed to stay a few minutes to dry, strips of metal being placed on the edge to prevent its curling up. The mould is next taken off the form, all superfluous paper cut away, and put on the table of the drying box to further dry. A "lip" is pasted at one end consisting of brown paper, and should be sufficiently long to hang out of the top of the casting box when placed ready for casting. Casting the plate is the next operation. The mould is placed on its back on the bottom plate of the casting box, with the lip hanging out at the end of the plate; the gauges, consisting of strips of iron a pica in thickness, are placed down each side and along the bottom of the mould, reaching to the top of the plate. A piece of paper is placed over the whole, the top plate brought down, and the screw applied. The box is next placed in a perpendicular position and the metal is poured between the protruding gauges and papers. In a few seconds the metal is set, the box placed in a horizontal position, the lid removed, and the plate will be found. The mould being removed, the tang, or pour, *i. e.*, the superfluous metal, is cut away, when the plate can be trimmed and mounted on wood and is ready for use.

The paste for flong may be made by taking say 1 pound of bookbinder's paste, 1 ounce whitening beaten to a powder, 1 ounce glue (melted in double its weight of water), 1 ounce starch, and ¼ ounce powdered alum. Mix well together, reduce to consistency of thick cream, and strain through a sieve, when it will be ready for use.

To test the metal for the proper heat for casting, dip into the molten metal a piece of white paper; if the paper is scorched black, it is too hot; if it is turned cream color, it is just right. Stereo metal is not so hard as type metal, and consists of say 85 per cent of lead and 15 per cent of regulus of antimony.—*British Printer.*

The Art of Poetry by a Poet.

Poetry is commonly thought to be the language of emotion. On the contrary, most of what is so called proves the absence of all passionate excitement. It is a cold-blooded, haggard, anxious, worrying hunt after rhymes which can be made serviceable, after images which will be effective, after phrases which are sonorous; all this under limitations which restrict the natural movements of fancy and imagination.

I have sometimes thought I might consider it worth while to set up a school for instruction in the art. "Poetry taught in twelve lessons." Congenital idiocy is no disqualification. Anybody can write "poetry." It is a most unenviable distinction to have published a thin volume of verse, which nobody wanted, nobody buys, nobody reads, nobody cares for except the author, who cries over its pathos, poor fellow, and revels in its beauties, which he has all to himself.—*Dr. O. W. Holmes.*