# “A Day at the London Marble-Works”


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The 1841 article begins:

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This article, which begins on the next page,
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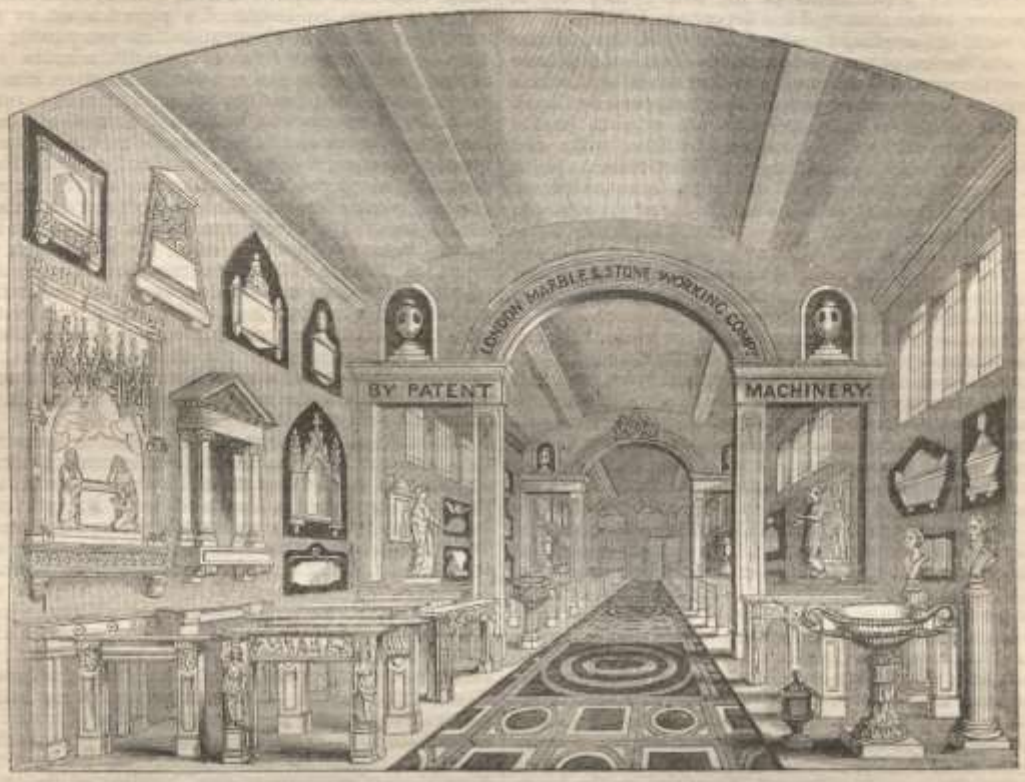
# A DAY AT THE LONDON MARBLE-WORKS.




[Show-Room of the London Marble Working Company, Esher Street, Millbank, Westminster.]

THE cutting of a piece of stone, and bringing it to a form and appearance adapted to the purposes of the builder, are operations which, until the last few years, have undergone but a very slight amount of change. The pickaxe at the quarry, and the saw and chisel at the mason's yard, have probably for ages been the instruments by which these operations have been conducted; and, indeed, so far as regards the common building-stones, the same remark may be made in our own day. The more costly kind of stone, to which we give the name of *marble*, and which, from its nature, is susceptible of a high and durable polish, requires for its due preparation an amount of labour far exceeding that which is customarily bestowed upon the commoner kinds of stone; and this circumstance has led, within a period comparatively recent, to the construction of machines which enable the processes of sawing, grinding, polishing, &c. to be performed with more expedition and less expenditure of manual labour than characterized the same operations formerly. Were it not for this circumstance, we should not probably have called the reader's attention to this department of mechanical art; but there are many points connected with the subject at the present day which deserve a little notice.

So far as stone is employed in large blocks for the construction of buildings, strength and durability are the chief qualities for which the material is valued; but when we have a substance such as marble, in which delicacy and purity of colour are combined with a susceptibility of receiving a high polish, and of being cut into elegant forms, a new measure of value is obtained, our notions of *taste* and *beauty* are at once appealed to, and the refining influence which objects of taste exert on mankind is shared by this substance in common with some others. That this is felt to be the case, is shown by the evidence given before the parliamentary committee on the Arts and Principles of Design, in 1836. It appeared to be an opinion on the part of many members of the Committee, that if so beautiful a substance as marble could be brought more plentifully and economically within the reach of the inhabitants of this country, it would tend to advance the arts of design, and to diffuse a taste for the elegancies which are so well appreciated in Italy. On this subject, Mr. Cowper gave the following evidence:—

"613. Would you not conceive, if the arts were generally diffused among the people, the black marble of Derbyshire and different marbles would be converted to purposes at present almost unknown?—Certainly.

"614. Is there not some tendency now existing towards the conversion of that and various marbles to purposes of art?—There is, both as to the various marbles and various other materials. At the marble-works, Esher Street, Horseferry Road, there is a beautiful system of machinery for working ornamental marble; mouldings, slabs, and pilasters of beautiful workmanship, are executed in British and foreign marble at a low price. The whole is the contrivance of Mr. Tulloch, an independent gentleman of great taste, as his large collection of paintings by the old masters testifies. He, from observing the great use of marble in Italy



(engraving caption) "Show-room of the London Marble Working Company, Esher Street, Millbank, Westminster." (circa 1841)

and in other countries, contrived this machinery for the express purpose of introducing marble into more general use in this country."

After a few questions relating to a patent mode of carving busts in ivory, Mr. Cowper was asked—

"632. If applied to oak or hard wood, the expense would be considerably lessened?—Yes; and I have seen the most elegant parquetry floor made by it, which would be too expensive to be attempted by hand. Much, if not all, of the Gothic oak carving for the new houses of parliament might be done by it; and with Mr. Tulloch's machinery in Esher Street, almost all the Gothic stone mouldings might be executed; so that by this application of art to manufacture, the splendid palace of the legislature might itself be increased in splendour.

"633. Could it be used for working in wood and wainscoting, and for ornaments?—Yes; and there would be no difficulty in doing so."

As it may not be uninteresting to the reader to know the means by which marble may be thus brought into a useful and ornamental form by machinery, we shall in the present paper detail the results of a visit recently made to the establishment referred to in the above evidence, illustrating our remarks by a few wood-cuts, and by such descriptions as will explain in a familiar way the action of the patent machinery, without attempting minute detail.

It is necessary to state the distinction between marble and other kinds of stone. This term is applied to those finer varieties of granular and compact limestone, which, being of a closer grain, are susceptible of a superior polish, and are remarkable either for their whiteness, their blackness, or the beauty and variety of their colours. In former times the appellation of marble (derived from the Greek verb, to *shine* or *glitter*) was indiscriminately given to many stony masses that admit of being polished; and accordingly we find alabaster, serpentine, basalt, porphyry, &c. occasionally included under that term. At present, however, it is customary to confine the term 'marble' to the kinds of limestone above alluded to, whether in a pure state, or varied with foreign substances mixed with or imbedded in the mass, such as serpentine, hornblende, quartz, &c. Where a piece of marble is not purely white (and white specimens are very rare), it has received its tints generally from the oxides of iron, the solution of which has, wholly or partially, penetrated the mass previous to its complete induration. Blue and green marbles frequently owe their tints to minute particles of hornblende. The black varieties, such as those of Ireland and of Derbyshire, are coloured by carbon, and sometimes by a kind of bitumen.

The ancient statues, of which so many beautiful specimens are still remaining, were formed of marble obtained from quarries which are met with even in the present day; and the general character of all such quarries may be judged from a notice of those at Carrara. Several ridges of low hills near the town of Carrara have been known for the marble-quarries worked there ever since the time of the Romans. The quarries are more than a hundred in number, some furnishing the purest white marble which the sculptor can obtain, and others marble variously tinted and adapted for ornamental purposes. The quarries were worked throughout the flourishing period of the Roman empire; after which they fell into disuse, and did not resume their importance till the Pisans took possession of them in the twelfth century.

Of this assemblage of quarries Mr. Simonds observes:—"Formerly on the sea-side, it now forms a deep nook in the mountain behind; but all Italy, all Europe, and all the world, might be covered with temples and peopled with statues of Carrara marble, yet the main stock would sustain scarcely a visible diminution by the loss of such fragments of its vastness. The rock is strewed over with these fragments detached from the heights by pygmies whom you scarcely see above, working with their puny tools, and blasting with gunpowder. The face of the noble rock, exposed for ages to the weather, is black; while the new fractures are dazzling white, and their crystal grain, dimly transparent, looks as if a single stroke of the chisel—a skilful one indeed—might make it breathe at once."* Twelve hundred workmen are constantly employed at the quarries; and the annual revenue is calculated at seven or eight hundred thousand francs. The blocks are carried down from the quarry in carts, drawn by oxen, to the Spiaggia, or beach of Avenza, where the storehouses are, and whence the marble is shipped on board the vessels that anchor in the roads. As the freight of the blocks would be uselessly increased if they were exported in misshapen masses, they are frequently sawn into squares by saw-mills, turned by some small streams which flow down the side of the hills in which the quarries are situated.

The marble, thus brought to London in the rough state, whether from Italy, from France, from Ireland, or from the northern parts of England, we will suppose to be consigned to the marble-working establishment before spoken of; and we will proceed to describe the general arrangement of the buildings, and the action of the different machines employed for working it.

Most Londoners, and perhaps most visitors to London, are aware that the Milbank Penitentiary is situated at a little distance north-west of Vauxhall Bridge. Immediately to the north of this building is Holywell Street, out of which branches a smaller street called Esher Street; and in this last-mentioned street is situated the London marble-works; or, to give the full name, the "London Marble and Stone Works;" for other kinds of stone are worked besides marble. The buildings comprise a long front range; three or four ranges of workshops and sheds; and open yards connecting these ranges one with another.

An arched entrance leads through the front range of buildings into an open court behind. On either side of this entrance are doors, the one on the left hand leading to offices and counting-houses, to which we shall not further allude. The entrance on the right is to a room occupied by monumental tablets and other articles in marble, in a state nearly approaching to completion; as well as plaster casts or models of which marble copies have been made.

From this lower room a staircase leads up to the show-room, which presents a very beautiful appearance. It is a kind of gallery, well adapted for the reception and exhibition of finished works in marble. The room is of great length, and is lighted by ranges of windows situated near the ceiling on both sides of the room, leaving ample space for monumental tablets, &c. beneath them. A clear passage is left through the middle of the room from end to end; on either side of which are ranged very numerous specimens of finished works in marble, such as chimney-pieces, pillars, pilasters, vases, urns, tables and table-tops, statues, busts, monumental tablets, mouldings, &c., and at one end of which are plates of looking-glass. Some of these are very elaborately worked; and from the diversified colours of the specimens of marble employed, and the taste with which they are arranged, the whole presents a very elegant appearance. Others are nearly plain, and exhibit the accuracy with which the machinery employed can produce flat surfaces of marble, for such purposes

* 'Tour in Italy and Sicily,' p. 576.

as paving for halls, conservatories, dairies, shop-fronts, &c. Most of these objects being temporarily placed in this room, the collection varies from time to time. A short time ago, among the more elaborate works finished at the establishment, were a large Gothic monument, a marble fountain for Sutherland House, and a marble copy of the large vase presented to the British Museum by Lord Western in 1839. At a more recent visit we observed several balustrades and other articles of polished black Irish marble for Hamilton Palace in Scotland.

Descending from the show-room, we pass out into the court or yard behind the front range of buildings. This yard is occupied by large blocks of marble; some in the rough state in which they were brought to London, either merely trimmed with the chisel or rudely sawn into thick slabs; others in a more or less prepared state. Among these we noticed blocks of black marble from Ireland, of the unusually large dimensions of thirteen feet by ten or eleven; and other blocks of white marble from Italy, much smaller in size, and exhibiting examples of the rude manner in which the hand-sawing of the Italians is effected.

To the left of this yard, and extending behind the southern end of the front range of buildings, is another yard, almost entirely filled with marble which has been already cut up into slabs of an inch or so in thickness, and which are deposited here till wanted for the subsequent processes. A few slabs of the finer kinds of stone are among them; but marbles of various colours and qualities constitute the chief materials operated on.

Crossing to the right of the central court or yard, we come to the buildings in which the working processes are carried on. The main building is of two stories, each measuring probably eighty feet by fifty. The lower story or room has doors on the north, south, and west sides, each leading to an open court or yard; while on the east side is a door opening into an engine-room, where a steam-engine, supplied with the necessary appendages of furnace, boiler, fly-wheel, &c., produces the moving-power by which all the machinery is impelled. This large room is so filled with machines in active operation, and the unceasing noise of the sawing and grinding processes is so bewildering, that a stranger requires some little time to analyze the complicated arrangements of the room. By beginning at the source of power, however, viz., the steam-engine, and tracing the communication from one point to another, the skilful arrangement of the whole gradually becomes manifest, and exhibits the ingenuity of the inventor, Mr. Tulloch. The fly-wheel of the steam-engine moves a shaft to which, by an ingenious adaptation of cranks, four rods are made to move horizontally. Each of these rods, by a reciprocating longitudinal movement, moves a set of saws inserted in frames; and the arrangement of each frame, as we shall presently explain, is such as to admit of a block of marble being cut by these saws. There are thus four sawing-frames or machines, ranged in a rectangular form, two to the north and two to the south of the rotating shaft; and the whole occupying the greater part of the eastern half of the room.

On the western side of the room, next to the door by which we enter, is a 'ripping-bed,' a machine for cutting slabs of marble into narrow strips or into small pieces. Next to this is a 'grinding-bed,' on which the slabs are ground after sawing, and previous to the process of polishing. Beyond, and towards the northern end of the room, is a 'moulding-bed,' a machine by which pieces of marble are worked into the architectural form of mouldings, such as squares, fillets, beadings, hollows, and ovalos. All these machines consist of various parts to which motion of some kind or other is given, in one of the many ways which are familar to those accustomed to machinery, but which can scarcely be made intelligible to general readers by written description. Shafts, drums, bands, cog-wheels, racks and pinions, bevel-wheels—all are brought into requisition, according to the kind of motion and the circumstances under which it is to be produced. At the eastern side of the room, in addition to the sawing-machines, is a lathe of large dimensions, turned by a shaft connected with the other machinery. At this lathe circular pieces of stone are moulded, or provided with the architectural mouldings just alluded to; and by it also circular columns are turned.

We will now pass to the upper story of the building, corresponding in size with the lower. This room is lighted on all four sides by windows, and contains a great number of workmen employed principally in the finishing processes of marble-working. There are several openings in the floor, to make room for the upper parts of the large sawing-machines below, and for some of the motive apparatus by which the machines are worked. Between and around these openings work-benches are erected, at which the men are employed. The operations are mostly effected by hand; but there are two machines on the western side, called 'polishing-beds,' at which the finishing operation is given to slabs and other flat pieces of marble. A door from the southern end of this room leads to the show-room.

We now leave the large building, and pass through an open shed or shop attached to its western wall. This shed exhibits an instance of the ubiquity (if we may be allowed the term) of steam-power; for by carrying a shaft through the wall which separates the shed from the sawing-room, three or four machines in the former are set in motion as effectually as if they were in the large building. The first of these, connected immediately with the shaft, is a grinding-machine, for grinding smaller pieces of marble than those operated on by the machine in the large building. Next to this, and connected with it by a revolving drum and band, is a machine for cutting circular slabs of marble of any dimensions up to six or eight feet in diameter. Adjacent to this is a third machine, by which small circles, a few inches in diameter, are cut out of slabs of marble, and by which, with a little modification of arrangement, cylinders, tubes, and columns might be cut. The remaining part of this shed is occupied by workbenches at which men are engaged in sawing, grinding, and polishing small pieces of marble, the working of which scarcely requires the aid of the machines.

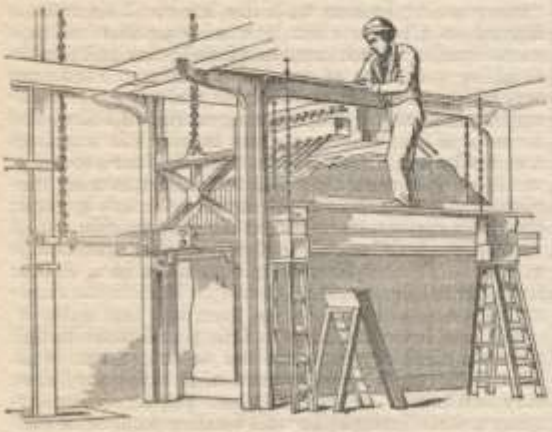
A narrow avenue separates the shed just alluded to from a long range of shops, in which those departments of marble-working are carried on in which the mallet and chisel are the principal instruments employed. Small benches, ranged laterally across the shop throughout its whole length, are occupied by men engaged principally in sculpturing or carving the ornamental parts of marble-work.

Beyond this range of carving shops is a millwright's-shop, in which the numerous saws, chisels, and other instruments of iron and steel employed in the processes of the manufacture are repaired and sharpened; and in which repairs and adjustments of the machinery are made. At the left of this is a large open yard entirely filled with slabs of statuary marble, which have been cut by the machines, and are deposited here till wanted. To the right or eastward of the millwright's-shop is another open yard, occupied partly by stores of stone and marble not yet brought under the action of the saw, and partly by the sand and the apparatus for cleansing and preparing it, required in the process of sawing.

We have now taken a glance at the general arrangement of the establishment, to show the mutual depen-

dence of its several parts. Our next object is, to trace the progress of a block of marble through the several processes which it, or the pieces into which it is cut, undergo, till its final conversion into slabs, pillars, mouldings, plinths, vases, or other specimens of marble-work. We shall thus have an opportunity of describing the particular action of all the machines separately, as they are brought into requisition.

The first machine employed on a block of marble after it is deposited in the manufactory, is the large sawing-machine, one of which is represented in the



annexed cut. There are five or six of these in operation, but the action of any one will illustrate that of all the rest. The process of sawing must of course be regulated according to the purpose for which the marble is employed. In a monumental tablet, the pieces of marble employed are generally broad, flat, and thin, whether or not they be highly decorated. In a chimney-piece, the several parts are likewise made from rather thin slabs and strips; in marble steps, table-tops, pavements, &c., the same remark applies; and indeed in the larger proportion of articles made of marble, the pieces from which they are formed are flat slabs or sheets, rather than massive pieces. In many of the ornamental purposes to which marble is applied, a foundation of commoner stone, of brick, of wood, or of cement, is first formed, and then the marble is superposed merely as a sort of casing. It results from this mode of using it, that a block of marble is in most cases converted into slabs of an inch or so in thickness before being applied to its ulterior purpose.

This first process of sawing is that in which the application of machinery is perhaps of the greatest importance, not only as regards the expenditure of manual labour, but also in reference to the accuracy with which the cutting is effected. With regard to the first point, many persons must have observed the singularly inefficient way in which the muscular power of a man is exerted in the common mode of sawing a stone. He sits at one end of the stone, grasping with his hands one end of a frame which contains an iron saw or cutter, and this saw he pushes to and fro as a means of dividing the block of stone or marble into slabs. Now it is manifest on a very little consideration, that his muscular strength is not equally effective as a working-power during these reciprocal movements; to push and to pull, to draw upwards and to draw downwards, to extend the hands from the body and to draw them to it, are respectively efforts which produce very unequal effects. If we watch the proceedings of a stone-sawyer, we shall also see that the saw frequently 'jars,' or has a tremulous motion consequent on the unequable manner in which it is moved; the result of which is, that the cut is not equally effective throughout the whole length of the block. All these circumstances combine to render the cutting by hand a very slow one.

With respect to the accuracy of the cutting, it may well be supposed that this is with difficulty attained by hand. The blade of the saw or cutting instrument is not above three or four inches wide, and is extremely apt to twist a little out of the vertical plane. If we were to attempt to cut through a large cheese with a common knife, the cut would be more and more irregular in proportion as the blade of the knife was narrower. So in the case of the stone; the narrowness of the blade—necessary to ensure its easy passage through the stone—renders it so liable to deviate from the vertical plane, that a perfectly level cut is almost unattainable by hand. This irregularity produces two ill consequences: it renders a laborious process of grinding necessary, in order to produce a level surface; and it occasions a waste of material, which is of serious importance if the quality of the marble be valuable. Of this latter fact we saw a striking instance. In the central yard of the marble-works were the two halves of a large and very fine block of statuary marble, which had been cut into two in Italy before exportation. The cutting had been effected by hand; and on glancing the eye along the surface of one of the pieces thus cut, it was obvious that the surface was about nine inches out of a true plane, the saw having twisted in various directions during the process of cutting. The distortion thus occasioned affected both halves equally, for a convex protuberance in one half had a corresponding depression on the other; and to bring both these to a true surface, the middle portion of the one and the edges of the other had to be sawn or ground away to the depth of nine inches. It happened that this block was one of the finest specimens of purely white marble, a fact which could not be fully ascertained until the cut was made; the quality was so valuable, that the portion wasted by the irregular sawing would, if cut into slabs, have been worth a sum estimated by the proprietors at nearly a hundred and fifty pounds.

These are some of the circumstances which render the employment of machinery very important; and Sir George Wright and Sir James Jelf some years ago devised machines for these purposes. Their attempts, from various causes, were not permanently successful; but the mechanism of Mr. Tulloch has now been in operation several years. The sawing-frames each consist of a cast-iron framework, to hold the working machinery together, about twelve feet long. A horizontal rectangular frame, longer than the block to be cut, and wider than the block is thick, has mechanism at each end by which a number of saws may be fixed parallel to the length of the frame, and with the blade of each saw in a vertical plane. By means of pins and wedges, the saws can be fixed at any required distance apart; suppose, for instance, that a block is to be cut into a number of slabs each one inch thick; an equal number of saws would be fixed in the frame strictly parallel one to another, and exactly an inch apart: so that the saws themselves would ensure the accurate regulation of the thickness of the slabs. The saw-frame is capable of sliding in vertical grooves in the cast-iron supporters, and is balanced by weights connected with it by a chain passing over a pulley above; the saws are thus kept at a height from the ground corresponding to the part of the block which is being cut; and as they are a little heavier than the balance-weight, they gradually descend by their own pressure as the cutting proceeds.

(engraving above) Large Marble Sawing Machine circa 1841

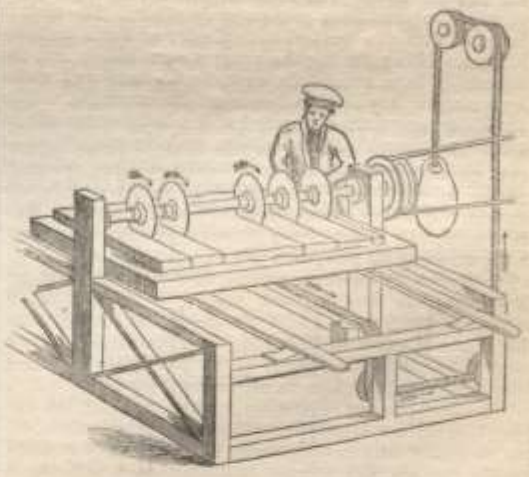
The saws here spoken of are rather unfortunately named. A stone-saw is not a saw at all. It is merely a piece of soft sheet-iron, with a blunt, smooth, straight edge, unprovided with teeth. Its action is not, properly speaking, to *cut* the stone, but to separate the particles of the material by friction. The effect is much increased by the addition of sand and water, the latter of which in some degree softens the stone, while the sharp particles of the former aid the frictive action of the saw; the small hard particles which constitute sand may indeed be deemed substitutes for the teeth of a saw. The quality of the sand is varied according to the nature and hardness of the stone to be cut; coarse sharp sand being used for soft kinds of stone, while very fine sand is better fitted for the harder stones. At the marble-works the sand employed is obtained from the neighbourhood of Croydon. It is well washed in large vessels, in order to free it as much as possible from extraneous substances; after which it is placed in a large brick receptacle covered with a roof, but open to the air, where it is kept till wanted. The cleanness of the sand employed is a matter of considerable importance; for if a small fragment of wood, or a grain so large that it will not penetrate (but rolls over) the stone, gets among the sand, the action of the saw is much impeded, and the removal of the obstacle is very difficult.

We will suppose that a block of Italian marble, eight or ten feet long, five or six wide, and one and a half thick, is to be cut into as many inch slabs as it will make, say sixteen. Sixteen saws are fitted into the frame parallel and equidistant, and the whole are lifted up by means of a windlass acting on the balance-weight above, to a height sufficient to allow the block of marble to be placed edge uppermost beneath them. The block is placed as nearly vertical as practicable, and is wedged and supported so as to remain firm. A very ingenious little machine, in which Mr. Tulloch has shown much inventive contrivance, is then suspended over the block, for supplying the saws with the requisite amount of sand and water. In the ordinary method of sawing by hand, a board is placed so as to slope towards the fissure made by the saw; and at the upper part of this board is placed a vessel of water, from which a small but constant stream is running down the board into the opening. A quantity of sand previously washed is also placed on the board at a little distance from the point where the water is running; and a portion of this sand is drawn forward by the workman into the running water by means of a stick with a hook at the end, and carried down gradually into the fissure made by the saw. But by Mr. Tulloch's contrivance several saw-fissures are supplied with sand and water at once. An iron cistern, about two feet long, one high, and one wide, is filled with water; and in each side are fixed about twenty cocks. The water, slowly flowing from these cocks, falls into an equal number of little grooves formed in the bottom of a box filled with sand; and these grooves are so constructed that the sand and water flow out together at a number of little openings on one side of the box. These streams of sand and water are then so directed as to flow each into one of the saw-fissures. As there are two grooved boxes, one on each side of the cistern, there are two streams of sand and water flowing into each fissure. This is one of those small pieces of mechanism frequently met with in our manufactures, in which more inventive ingenuity is often called for than in machines apparently much more important.

The saws being made to rest on the block, and the sand and water being arranged to flow into the fissures as soon as they are made, the saw-frame is set into reciprocating horizontal motion by a connection being formed between it and the working shaft of the steam-engine. By a particular application of a parallel motion somewhat similar to that of Watt, the saws are moved in a strictly horizontal manner, the length of the stroke of each saw being about eighteen inches. When the saw comes to the end of its stroke, it is lifted up a little by means of an inclined plane, so as to allow the sand and water to flow down beneath it in the crevice. As the cutting proceeds, the assemblage of saws descend by their own weight being a little greater than that of the balance; and the reciprocating motion continues till the block has been entirely divided into slabs.

There are four machines of the kind just described, all connected by rods with the working-shaft of the steam-engine, and all capable of receiving and working an equal number of saws. But within the last few years blocks of black marble from Galway have been procured of such large dimensions that the sawing-machines are not able to receive them. For working on such blocks another sawing-frame has been erected out in the open yard, but still in connection with the working power of the steam-engine. We saw a block of Galway marble, thirteen feet long by ten feet wide, under process of sawing in this frame; it was being cut into slabs for forming the landings of a grand staircase in Hamilton Palace.

After a block of marble has been cut into slabs, it is for many purposes required to be reduced to the form of narrow strips, such the several parts of a chimney-piece, or of a monumental tablet; or else into small pieces of various shapes. The large sawing-frames are not adapted for this smaller kind of workmanship, which is therefore effected in a machine called a 'ripping-bed,' represented in the annexed



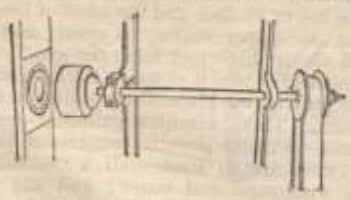
cut. This is a kind of table, twelve or fourteen feet long, six or seven wide, and three high; the flat of which is made of cast-iron. On this iron bed is placed one of plank, forming the top of the table; and on this the slabs which are to be cut into strips are temporarily fixed with plaster of Paris. A horizontal axle revolves a few inches above the table, and on this axle are fixed vertical cutters, consisting of circular pieces of soft iron about eight inches in diameter, the lower edge of which, while revolving, nearly touches the table. The iron bed on which the planking and the slab rest is connected, by means of pulleys, with a heavy weight, by which it is drawn slowly forward; the edge of the marble, thus forcibly drawn in contact with the edge of the cutter, is subjected to its cutting action, and is

(engraving above) "Ripping-bed" used to cut marble into small pieces of various shapes circa 1841.

pulled forward by the weight as fast as the cutting is effected. The axle, being several feet long, is adapted for the reception of several cutters at once, which may be so adjusted as to produce strips of any required width. Suppose, for example, it were required to cut a slab, three feet wide, into one dozen strips, all of different width: a series of cutters, all of equal diameter, would be fixed upon the axle at such relative distances apart as would correspond with the width of the strips to be produced, and all the cuttings would be made at one time. One man attends to the machine, adjusting the cutters to the axle, arranging the marble on the bed, adjusting the balance-weight to the work required to be effected, and keeping up a constant supply of sand and water at the fissures which the cutters make in the marble.

The form of this machine adapting it only to make rectilinear cuts, the production of a curve requires other arrangements. We have before stated that there are two machines for cutting circular pieces of marble from flat slabs. One of these, for circles of large dimensions, consists of a flat bed capable of receiving a slab six or eight feet in diameter, in a horizontal position. Above this is a vertical pillar, to the lower end of which are attached four arms at right angles with one another, and all exactly equal in length. To the bottom of each arm is fixed a piece of iron, such as the saws are made of, bent into a curve corresponding with the curvature of the circle to be produced. These pieces of iron are capable of being fixed at any distance from the centre, and the distance chosen in any particular instance depends on the diameter of the circle to be cut. When the arms revolve, the pieces of iron attached to their lower surfaces become cutters: each is capable of making a circular cut in the surface of the marble during one rotation, and all acting in conjunction to produce a more speedy effect. The slab is fastened down to the bed with plaster of Paris, to keep it from shifting during the process of sawing; and the fissure is kept constantly wetted with sand and water by a man or boy in attendance on the machine. The revolving arms are connected with a balance-weight in such a manner that the cutters sink in proportion as the fissure in the marble becomes deeper, until at length a circular piece is entirely cut out of the slab. We saw two beautiful variegated marble table-tops, about six feet in diameter, which had been cut to the circular form by this machine.

The smaller circular cutter acts on somewhat the



same principle as the larger. A vertical shaft is set in rotation, to the lower end of which is attached a hollow cylinder of sheet-iron. The lower edge of this cylinder acts as a cutter, the marble to be cut being placed in a stand or bench immediately beneath it. Cylinders of different sizes are kept for circles of varying diameters, and their depth is such that three or four pieces of marble might be laid one on another, and all cut at once. The same means of fixing the marble to the bench beneath, of supplying the fissure with sand and water, and of elevating and depressing the cutters, are adopted in this as in the other machines lately described. Some years ago a contrivance, bearing a certain degree of resemblance to this, was devised for forming round pillars and hollow cylinders and tubes of stone; the cutting instrument in both cases being a cylinder of metal. By a small circular cutter of this kind, pieces of marble may be cut in great number, and with great accuracy, for mosaic or tesselated pavements.

But a mere circle, with a plain edge, is only one of the forms in which a curved piece of marble is required for ornamental purposes. The edge itself, or portions of a pillar or pedestal, may be required to present some architectural form, such as squares, rounds, hollows, &c. To give this form to a piece of marble a lathe is employed, differing little from the common turning-lathe. A small block of marble in a rough state, or a small circular piece of slab, as the case may be, is attached to the lathe, and set into rapid rotation by a shaft connected with the steam-engine; and a workman proceeds to give it the required form. This he does not effect with an iron cutter used with sand and water, nor with a mallet and chisel, but with long sharp-pointed instruments of steel, the points of which he brings in contact with the stone in the same manner as the turner uses his chisel. The stone flies off in small fragments by the use of the sharp-pointed instrument; and when a rough approximation to the shape has been thus produced, other tools, such as gouges, &c., are employed to complete the form of the piece of marble. Pillars and other objects of a similar kind could be worked by these means.

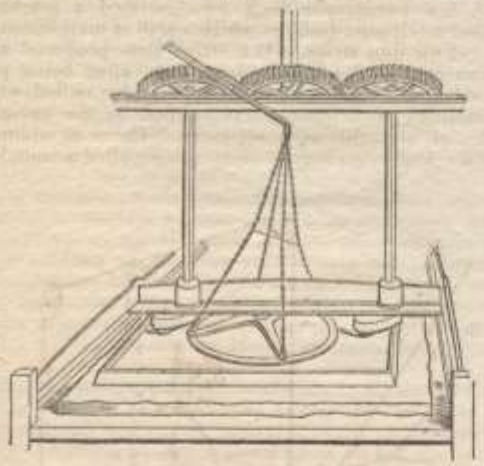
A few paragraphs back we described a machine called a 'ripping-bed,' by which a slab of marble could be cut up into strips. The strips thus produced are sometimes used in their plain form, after being polished; but they are more frequently diversified with mouldings, in a manner exemplified by the upright sides of a marble chimney-piece. These mouldings are worked by an ingenious machine called a 'mould-

ing-bed,' bearing a good deal of resemblance to the 'ripping-bed,' so far as regards the flat table on which the marble is laid, and the position of a revolving axle a little above the table. But the cutters by which the mouldings are wrought are altogether different: they consist not of circular pieces of sheet-iron, but of masses of iron whose circular surfaces have been wrought into various forms, the counterparts of the different mouldings to be produced. We saw several hundreds of these cutters, adapted for all the various patterns likely to be demanded. When a strip of

(engravings above) (left) Small Circular Marble Cutter; (right) A "Moulding-bed" circa 1841

marble is to be moulded to any particular form, an iron cutter corresponding with that form, or rather, the counterpart to it, is placed on an axle just above the bed of the machine, and firmly fixed in its place. The strip of marble is then fixed down with plaster of Paris to a board which is capable of being moved slowly forward by a rope and pulley, as in the other machines, at such a height as shall just allow the iron cutter to make the required depth of cutting. The cutter being set into rapid rotation, the marble is brought up to it, and is cut away by the action of the revolving iron. The marble advances onwards as fast as it is cut, and then presents a series of parallel mouldings on its surface, the counterpart of those in the cutter.

We have now, we believe, described all the machines whose action is to cut the blocks of marble into smaller pieces of various forms, and have next to speak of those whose office is to give a smooth and polished surface to the pieces so cut. The action of the cutters, whatever be their form, necessarily leaves a certain degree of roughness of surface; and if the cutting be made irregularly, the surface is not only rough, but uneven. Under all circumstances, therefore, a slab or piece of marble requires to be ground after it is cut. The means of effecting this at the marble-works are various, according to the size of the slab to be operated on. If the slab be large, a 'grinding-bed,' situated



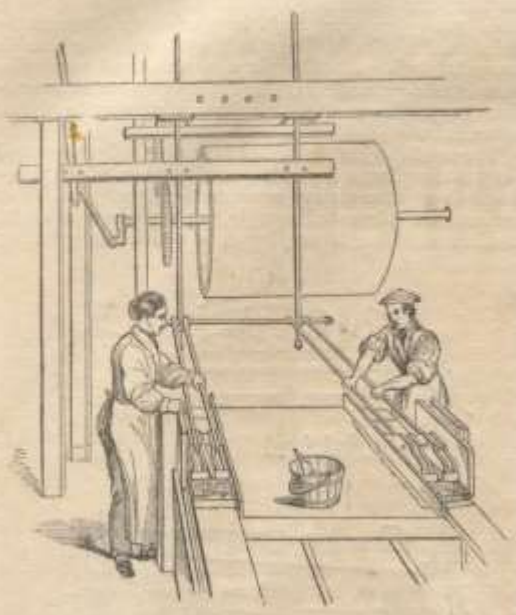
near the large sawing-frames, is employed. This consists mainly of a very strong wooden bed or table on which the slab is laid, and of a large cast-iron plate whose lower surface performs the grinding process. The bed is subject to a very slow reciprocating or backward and forward motion, by means of rack and pinion work beneath; while the iron plate, which is suspended from above, has a very singular motion given to it, not exactly either circular or rectilinear, but a compound of both. The combination of these movements in the bed to which the marble is attached, and in the iron plate which is superposed on it, is such that the motion of any one point may be compared to the curves on an engine-turned watch. The object of this very ingenious contrivance is, that every part of the slab may be ground in the same degree and in the same manner, and that the movement of the iron over any particular part of the surface of the marble may be as varied in direction as possible. This process, like that of sawing, requires a supply of sand and water to aid the action of the iron. The supply is effected in a curious manner. The plate is surrounded by a raised ledge, and is pierced in various parts with round holes. It thus forms a kind of shallow box with a perforated bottom; and being filled or partially filled with moistened sand, the latter finds its way down through the holes, and moistens the whole surface of the marble beneath the iron. The plate is capable of being elevated and depressed to different heights, to accommodate the thickness of the marble which may be placed beneath it.

The machine just described is particularly calculated for grinding large flat surfaces of marble, which it reduces to a plane almost mathematically correct. But for smaller pieces of marble, or the edges of slabs, another machine is employed, in which the grinding

instrument, although arranged in a totally different manner, is still made of iron. A circular plate of iron, about five feet in diameter, and two inches in thickness is placed in a horizontal position, and connected with a vertical shaft or axle which passes through the centre. This axle, by the aid of intervening wheelwork, is set into rotation, and in its turn rotates the iron plate. The lower surface and the edge of the plate are hidden, but the upper surface is open; and being at a height of about three feet from the ground, it forms a convenient bed or bench at which the men may work; it is in fact an iron workbench revolving in a horizontal direction. This 'circular grinding-bed,' which the workmen—with the peculiar nomenclature of which most workmen are so fond—call a 'roundabout,' is moistened with sand and water; and any pieces of marble which are to be ground by its aid are pressed down firmly upon it. The iron surface has the same effect on the marble in this instance as in the former, the difference being in the kind of motion given to the iron, and in the iron being beneath the marble instead of above it.

The action of a surface of iron, used as in the two machines just described, is not to polish the piece of marble exposed to it, but merely to bring it to a perfect level, by removing all saw-marks and other irregularities of surface. But as one of the chief beauties for which marble is admired is the brillant gloss which its surface presents when highly worked, the slabs or strips, after being ground by one of the two machines described above, are carried to a polishing-machine, or 'polishing-bed,' situated in the upper floor of the

(engravings above) (left) A Marble "Grinding-bed" used for grinding (polishing) large, flat surfaces of marble; (right) A Circular Grinding-bed used to grind marble circa 1841



building. This machine is about twelve feet long, four or five wide, and three high. It consists of a flat bed on which the piece of marble is laid, and mechanism for working the polishing instruments. Each of these latter is about two feet long and four inches wide, formed of lead or some other heavy substance, and faced at the bottom with a layer of a peculiar kind of felt, adapted for the polishing of marble. Each polisher is connected by means of a long handle with the working machinery of the steam-engine, by which it acquires a backward and forward motion over the surface of the marble; and the arrangement is such that several polishers may be wrought at one time. All flat surfaces of marble, whether large slabs or narrow strips, may be polished in this way.

There are, in most worked specimens of marble, whether articles of furniture or of decoration, numerous small pieces which cannot be conveniently or economically prepared by the machines which have lately engaged our attention. This is especially the case where any elaborate carved-work forms part of the design. It thence results that there are a large number of men employed at the marble-works, besides those who are in attendance on the machinery. A brief notice of the modes in which the manual labour of these workmen is applied, will be a necessary sequel to our preceding details.

If a small piece of marble is to be cut in a manner which does not require the aid of the machines, a man uses a kind of small hand-saw, formed, like the larger saws, of a piece of soft iron without teeth. This piece of iron is fixed into a handle, and it is used nearly in the same manner as a common saw; the workmen keeping the fissure in the marble constantly supplied with sand and water. The process of grinding small pieces of marble by hand is in like manner a miniature representation of the analogous process as effected by machinery. Small pieces of iron, attached to wooden handles of a convenient shape, constitute the grinding tools, which are used with sand and water.

The chisel and mallet are tools of which we have not had much occasion to speak; but they are much used in the finer and ornamental parts of the work. This is often very slow and tedious work. The piece of marble to be carved is placed upon a bench; and the workman, provided with chisels, gouges, and pointed instruments of various shapes, chips away the marble until he has formed the required device or pattern. Foliage, groups of figures, and indeed all patterns in which varying undulations of surface occur, are produced by these means. We saw, under process of carving, several elaborate balusters of black marble for a staircase at Hamilton Palace. Each baluster was about a yard in length, and five or six inches in thickness, and profusely decorated in every part. One piece of marble, without joint or division, formed each baluster; so that the carver had to chisel away just enough, and no more, to produce the required pattern. The beautiful substance of which these balusters were formed suggests a remark on the store of material which we have in our own country and in the sister island. This black marble, brought from a quarry near Galway, is perfectly spotless, as black as jet, and susceptible of a very high polish; and as the blocks procurable from thence are among the largest which have ever been brought to England, the marble is capable of being applied to a great variety of purposes. A visit to the British Museum will show that our quarries are capable of supplying black and coloured marbles of great beauty. In the New Mineralogical Gallery are two tables, one presented to the Museum by Mr. Martin, and the other, in 1838, by the Duke of Rutland. The former consists of a richly variegated green and white serpentine marble, brought from the quarry of Ballinahinch, near Galway. The latter consists of two kinds of marble; the frame-work, legs, and bottom plinth of the table being of black marble, brought from Bakewell in Derbyshire; and the top being composed of a very curious sponge-coloured slab of stalagmitic marble, from Hartle in the same county. If the means were attained for working up these fine marbles in an expeditious and economical manner (and the patent machinery seems calculated to aid in producing this result), the more extensive use of our home quarries would in all probability follow.

All the pieces of marble which have passed through the hands of the carver require to be ground and polished before the beauty of surface can be developed. This is effected by using small pieces of different substances, such as cast-iron, gritstone, smooth stone, and slate, shaped so as to suit the diversities of ornament, and rubbed over the marble until the latter is brought to a fine surface. These are processes which it is not probable machinery will ever be made to perform. Instead of expressing any surprise at this circumstance, we cannot but admire the ingenuity which could effect so many different processes by machinery: the cutting of slabs from the block; the cutting of strips from a slab; the cutting of various-sized circles; the cutting of architectural mouldings in a slip of marble; the grinding of a large slab by one machine, and of small pieces by another; the polishing of the pieces thus ground; and the adjustment of machinery by which all these processes are performed through the agency of one working shaft of the steam-engine; required no small share of inventive talent.

In conclusion we may say, that if a visitor is resolute enough to bear the "setting his teeth on edge" by the noise of the sawing, there is much to interest him at this establishment, which we have been obligingly permitted to describe.

(engraving above) Polishing-Machine, or "Polishing-bed" used to polish marble circa 1841