MECHANICS, PHYSICS, AND CHEMISTRY.

Description of the Design for the Building for the Exhibition of all Nations, and of the gradual development of the method of construction employed. By MR. PAXTON.*

The author began by stating, that the Great Exhibition Building was the development and result of a very long series of experiments, made by him at Chatsworth, in the erection of the different horticultural buildings there, on which he had been engaged since the year 1828. The pine-house, built in 1833, was the first in which the ridge-and-furrow roof—an essential feature in the great building—was employed. This roof was contrived by the author, so that the glass in it might be more nearly at right angles to the slanting and weak, though valuable, rays of the morning and evening sun, than the glass used in straight roofs. So well was it found to answer, that in 1834 he built a green-house, 97 feet 6 inches by 26 feet, with a mean height of 14 feet 6 inches. This building, even under the old glass tax, cost only 2*d.* per cubic foot. It was followed, in 1836, by a "curvilinear" hot-house, 60 feet by 26 feet, so called from the roof being a quarter circle: here the Victoria Regia first flowered in 1849. In the following year the great conservatory was commenced; and, in order to economize labour in its construction, the author invented a machine for forming the sash-bars, by which he effected a saving of £1400, and for which the Society of Arts, in 1841, gave him the silver medal. This has been the type of all the machines for wooden sash-bars since used. For this building sheet glass was first made, by the Messrs. Chance and Co., of the length of 4 feet,—nothing beyond 3 feet having ever before been made. The great conservatory is 277 feet long, 123 feet wide, and 67 feet to the crown of its domed roof.

In a conservatory at Darley Dale, in 1840, the author first employed the ridge-and-furrow roof on a level,—that is, neither curvilinear nor inclined, as in the former cases. The breadth of this building is 17 feet; and so successful was it, that, in a letter from the proprietor, it was said to be constantly used as a sitting-room by his family. This was more extensively carried out in the new Victoria Regia house, 60 feet 6 inches in length and 46 feet 9 inches in breadth, with a clear span for the roof of 33 feet 6 inches; and which, on its small scale, is a perfect type of the great building.

The Industrial Building.

The inducement for offering a design for this building was the following:—When plans for the structure were sent in by various parties to the Royal Commissioners, many forcible reasons were urged, in the daily papers, against the propriety of erecting a large building of bricks and mortar in Hyde Park. It was then that the author turned his attention to the matter; and he became at once convinced, that the least objectionable structure, to occupy a public park, would be an erection of cast iron and glass; whilst, at the same time, a building of this description would be the

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very best adapted for the purposes of the exhibition. The time for receiving the designs had expired; but, from having the whole matter already digested, and the system of ridge-and-furrow *flat* roofs so fully in his mind, it only required the adaptation of the principle, on a large scale, to suit the vast building for the exhibition. His plans were got up in about ten days, and ultimately received the approval of the Commissioners.

The design for the building was planned—first, with particular consideration as to its fitness for the object in view, namely, the Exhibition of 1851; secondly, its suitableness for the site proposed; and lastly, with a view to its permanence as a winter garden, or vast horticultural structure, or a building which might, if required, be again used at any future period for a similar exhibition to that of 1851.

One great feature in the present building is, that no stone, brick, or mortar, need be used; but the whole is composed of dry material, ready at once for the articles to be exhibited. By combination of no other materials but iron, wood, and glass, could this important point be effected; which, when we consider the limited period allowed for the erection of so stupendous a structure, may almost be deemed the most important object. The absence of any moist material in the construction, together with the provision made for the vapors which must arise and be condensed against the glass, enables the exhibitor at once to place his manufactures in their respective situations, without the probability of articles, even of polished ware, being tarnished by their exposure.

It may be important here to state, that it is unnecessary to cut down any of the large timber trees, provision being made, by means of a curvilinear roof over the transept of the building, for them to stand beneath the glass, and by a proper diffusion of air they will not suffer by the enclosure. (Mr. Paxton here proceeds to describe the drawings of the plans of the building, as exhibited upon the walls of the room, shewing the original idea of the building and the improved design as it now stands.) The height of the centre aisle is 64 feet, the side aisles 44 feet, and the outside aisles or first-story 24 feet. The transept is 108 feet in height, and is covered with a semicircular roof, like that of the great conservatory at Chatsworth, in order to preserve the large elm trees opposite to Prince's gate. The whole number of cast iron columns is 3300, varying from 14 feet 6 inches to 20 feet in length. There are 2224 cast and wrought iron girders, with 1128 intermediate bearers, for supporting the floors of the galleries over the large openings of the aisles. The girders are of wrought iron, and those for the galleries are of cast iron. The fronts of the galleries are also supported by cast iron girders. The dimensions of the building are 1851 feet in length, and 456 feet in breadth in the widest part. It covers, altogether, more than 18 acres, and the whole is supported on cast iron pillars, united by bolts and nuts fixed to flanches turned perfectly true, and resting on concrete foundations. The total cubic contents of the building are 33,000,000 feet. The six longitudinal galleries, 24 feet in width, running the whole length of the building, and the four transverse ones, of the same dimensions, afford 25 per cent. additional exhibiting surface to that provided on the ground floor. This extra space is suited for the display of light manufactured goods, and will also give a complete view of the whole of the articles exhibited, together with an extensive view of the interior of the building. In order to give the roof a light and graceful appearance, it is built on the ridge-and-furrow principle, and glazed with British sheet glass, as previously described. The rafters are continued in uninterrupted lines the whole length of the building. The transept portion, although covered by a semicircular roof, is also on the angular principle. All the roof and upright sashes being made by machinery, are put together and glazed with great rapidity,—for, being fitted and finished before they are brought to the place, little more is required on the spot than to place the finished materials in the positions intended for them. The length of sash-bar requisite is 205 miles. The quantity of glass required is about 900,000 feet, weighing upwards of 400 tons. All round the lower tier of the building, however, will be boarded with fillets planted on in a perpendicular line with the sash-bars above.

The gutters are arranged longitudinally and transversely: the rain-water passes from the longitudinal gutter into a transverse gutter over the girders, and is thus conveyed to the hollow columns, and thence to the drains below. As these transverse gutters are placed at every 24 feet apart, and as there is a fall in the longitudinal gutters both ways, the water has only to run a distance of 12 feet before it descends into the transverse gutters, which carry it off to the hollow columns or down-pipes. The grooves for carrying off the moisture which condenses on the inside of the glass are cut out of the solid; in fact, the whole gutter is formed by machinery at one cut. The gutter is cambered up by tension-rods, having screws fixed at the ends, so as to adjust to the greatest nicety, as is the case with the wrought iron girders which span the Victoria Lily House.

Many experiments were tried in order to find out the most suitable floors for the pathways of horticultural structures. Stone was objectionable, chiefly on account of the moisture and damp which it retained. The difficulty of getting rid of the waste from the watering of plants was also an objection; but perhaps the greatest was the amount of dust from sweeping. It likewise appeared that close boarding for pathways was open to many of the same objections as stone; for although damp and moisture was in part got rid of, yet still there were no means of immediately getting rid of dust. These various objections led the author to the adoption of trellised wooden pathways, with spaces between each board, through which, on sweeping, the dust at once disappears, and falls into the vacuity below. Whilst the accomplishment of this point is most important in plant-houses, it is doubly so with the industrial building, where there will be such an accumulation of various articles of delicate texture and workmanship. Before sweeping the floors, the whole will be sprinkled with water from a movable hand-engine, which will be immediately followed by a sweeping machine, consisting of many brooms fixed to an apparatus on light wheels, and drawn by a shaft. Thus a large portion of ground will be passed over very quickly. The boards for the floor will be 9 inches broad and 1¼ inches thick, laid half an inch apart, on sleeper joists 9 inches deep and 3 inches thick, placed 4 feet apart. This method of flooring, then, possesses the following advantages:—It is very economical; dry, clean, pleasant to walk upon; admits of the dust falling through the spaces; and even when it requires to be thoroughly washed, the water at once disappears betwixt the openings, and the boards be-come almost immediately fit for visiters. The galleries will be laid with close boarding.

The *ventilation of the building* has been most carefully considered, and a most copious supply of pure air is provided. Four feet round the whole of the basement part of the building is made of *louvre boarding;* and at the top of each tier a similar provision of 3 feet is made, with power to add an additional quantity if required. In the centre aisle, also, the air will be plentifully admitted.

By simple machinery the whole of this ventilation can be regulated with the greatest ease. The advantages of this kind of ventilation are several. Louvre boards are very simple in construction; they can be opened and closed instantaneously with the greatest readiness; they nicely distribute the air, and yet admit a large volume of it; and, from the manner in which they are placed over each other, they effectually prevent the entrance of wet in rainy weather.

In order to subdue the intense light, in so large a building covered with glass, all the south side of the upright parts, and the whole of the angled roof, will be covered outside with canvas or calico, so fixed as to allow a current of air to pass between the canvas and the roof. In very hot weather, water may be poured on, which will very much assist in cooling the temperature within. Provision will be made to use the Indian plan of ventilation, if the heat is so intense as to render it desirable to have the temperature cooler than out of doors. A house was fitted up last summer at Chatsworth, as an experimental place to try this mode of ventilating, when it was found to answer the purpose admirably. The temperature was reduced in one hour from 85° to 78°, without any other means being used to increase the draft through the building. This sort of covering offers the following advantages:—the brightness of the light will be tempered and subdued; the glass will be protected from the possibility of injury by hail; the screen being placed on the outside will render the building much cooler than if it were placed inside; and through this provision the ventilation can be regulated at pleasure. From the side galleries, running the whole length of the building, there will be grand views of the goods and visiters below; whilst the transverse galleries in the middle and at the ends will afford ample means for general supervision, and will serve to communicate between the side galleries. Magnifying glasses, working on swivels, placed at short distances, will give additional facility for commanding a more perfect general view of the Exhibition. After the Exhibition is over, the building might be converted into a permanent winter garden, and have carriage drives and equestrian promenades made through it. Pedestrians would have about two miles of galleries, and two miles of walks upon the ground floor, and sufficient room would then be left for plants. The whole intermediate spaces between the walks and drives could be planted with shrubs and climbers from temperate climates. In summer the upright glass might be removed, so as to give the appearance of a continuous park and garden. A structure where the industry of all nations is intended to be exhibited, should, it is presumed, present to parties from all nations a building for the exhibition of their arts and manufactures that, while it affords ample accommodation and convenience for the purposes intended, would, of itself, be the most singular and peculiar feature of the exhibition: how far this has been accomplished, must be left to the community to decide. It will be seen that from the simplicity of the Exhibition building of 1851 in all its parts, together with the simplicity of the detail, its construction does not offer matter for much detail. The author, in conclusion, remarked, that structures of this kind are susceptible of the highest kind of ornamentation in stained glass and general painting; and that they may well be expected to come into almost universal use. This system of building, he said, is capable of application to manufacturing purposes, as well as general cemeteries; and even market-gardeners might advantageously employ it in the growing of foreign fruit for the London markets. In short, there is no limit to the uses to which it may be applied—no foresight can define the limits where it will end; and we may congratulate ourselves that in the 19th century, the progress of science and the spirit of manufacturers have placed at our disposal the application of materials which were unknown to the ancients, and thereby enabled us to erect such structures as would have been deemed impossible even in the early part of the present century.

Several questions were then put to Mr. Paxton with reference to the details of his plan, which he answered apparently to the satisfaction of the meeting.

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Latent Heat of Water.

In an article contained in the September number of the *Annales de Chimie et de Physique*, M. C. C. Person has pointed out a necessary correction of the determination of the quantity of heat which becomes latent in the melting of ice;—a correction which, although not very large, is yet interesting, and depends upon a somewhat curious fact. Dr. Black first determined the heat thus absorbed to be 80° Cent., (144° Fahr.) (That is, he determined that one pound of ice in melting, without change of temperature, would lower the temperature of 144 lbs. of water 1° Fahr.) But not much confidence was placed in the accuracy of his result. Wilke found 72, (129·6;) Lavoisier and Laplace 75, both of which numbers were in disaccordance with the calculation of phenomena. Finally, the very carefully conducted experiments of Provostaye and Desains, confirmed by those of Regnault, gave 79 (142·2) as the true result. It is this latter number which M. Person, admitting the entire accuracy of the experiments, proposes to correct. His objection is, that the whole heat absorbed by ice in melting cannot be determined by beginning the experiment at the temperature 0° (32° Fahr.) In fact, it is well known that in general, before any body melts, it becomes soft; and during this softening there is an absorption of heat. In some cases, as in wax, the quantity of heat thus absorbed exceeds that taken up in the actual melting. The experiments of Regnault themselves shew, that when the initial tempera-