COMPLETION OF WASHINGTON'S MONUMENT.

This great obelisk, of which the corner stone was laid nearly forty years ago, is at last completed, capped, and dedicated. The ceremony of deliverance to the President of the United States took place on the 21st of February last, and formed a brilliant event in the history of the national capital.

The structure has the distinction of being the highest spire in the world. It is in round numbers 597 feet in altitude above sea level. It is chiefly built of granite, faced with white marble. The shaft is 55 feet 1½ inches square at the base, walls 15 feet thick, and 34 feet 5½ inches square at the top, where the walls are 1½ feet thick. There is a central well 25 feet square. The total weight of the monument is 81,000 tons. In this week's SUPPLEMENT we give an official drawing of the structure, together with the report of Colonel Casey, the engineer in charge of the work, in which further particulars of the dimensions will be found. It is hinted in certain engineering quarters that the foundations of the structure are insufficient, and if not soon attended to, the monument will be likely to fall. The condition of the foundation forms a good subject for examination and discussion, and we trust it will receive attention by all who are qualified to judge of the matter.

THE ALASKA'S RUDDER.

On another page will be found illustrations showing the nature, place, and extent of the injury to the rudder of the steamship Alaska on her last trip to this port, together with description and dimensions of the new rudder lately made in this city.

The accident was a novel and peculiar one, and forcibly exhibits the suddenness with which unforeseen perils sometimes arise at sea.

The Alaska left Queenstown January 25, and experienced heavy weather from the start. The storm was especially severe on the night of Feb. 2, but abated the next morning, when a new danger arose. The ship, then about 80 miles southeast of Sable Island, suddenly refused to obey her helm, and it was found that her rudder was so broken as to be uncontrollable. In the main, as our illustrations will show, the rudder was intact; but from being a help to the ship it had become a source of grave peril, through being dashed from side to side as the ship rose and fell in the heavy sea. The officers of the ship exhausted their ingenuity in the effort to grapple with new problems which the broken rudder so suddenly presented, then proceeded to navigate the ship as well as they could without it. The sea was so heavy that the customary drag would not avail to steer the ship; and steering by means of the sails was but little more successful. It was impossible to keep the ship's head to the heavy seas, which broke over her and buffeted her about in a manner that would have foundered a less seaworthy craft.

After drifting helplessly for thirty-six hours, the Alaska sighted the steamer Lake Winnipeg, of the Beaver Line, which stood by until morning, and then came to the assistance of the disabled vessel. In the morning (Feb. 5) it was decided to use the Lake Winnipeg as a drag with which to steer the Alaska, and hawsers were passed from the one to the other as for ordinary towing. By deflecting the cables by means of the dragging steamer as described elsewhere, the same effect was produced as is obtained by shifting the helm. One of the cables parted during the next night, compelling the vessel to lie to until morning; but with this exception the improvised steering apparatus worked well, and the two ships proceeded slowly to this port, arriving off Sandy Hook on the morning of the 9th.

The Alaska had on board nearly three hundred passengers, whose safety with that of the officers and crew —to say nothing of the costly vessel and her freight— was imperilled by the accident, and remained in imminent peril for days.

The Alaska is one of the most admirably proportioned and fastest steamships afloat. Her gross tonnage is 8,000. Her engines are of compound inverted, direct-acting, cylinder type, the high pressure cylinder being 68 inches in diameter, and the two low pressure cylinders 100 inches diameter each. The indicated horse-power is 11,000, the highest one on a steamer in the world. The ship has four masts, and is steered by steam. She is built of iron in a series of water tight compartments, and is provided with the most modern methods for insuring comfort and safety at sea.

Yet, as we have seen, by the unexplained fracture of a relatively small piece of metal, this splendid structure, with her enormous power at perfect command, was almost as helpless as a log for many hours. Could anything have been done, with the appliances at her officers' command, to bring the broken rudder under control? The question is submitted to the ingenious readers of the SCIENTIFIC AMERICAN, as one practically worth considering. We should be happy to give space for any feasible suggestions that may be made toward a solution of the problems involved. It may be proper to observe that, had it been possible for the officers of the Alaska to devise a means of grappling and controlling the broken rudder, on the instant, it would have saved not only the present peril to the ship and her passengers, but the cost to her owners of a salvage charge of something like two hundred thousand dollars.

The problem is curious and practical. Inventive reader, how would *you* have gone about to solve it?

Whitworth Compressed Cast Steel.

The following is from the recent report to the President of the Gun Foundry Board:

Upon its first arrival in London, the Board was invited by Sir Joseph Whitworth to examine his works, but with the desire expressed that the visit should be postponed until the close of our foreign investigations. This request was, of course, readily acceded to, and it will be thus seen that previous to the visit to Manchester the members of the Board had received all the impressions that could be produced by viewing the operations at the chief steel factories in France and Russia, and the great factories of Sheffield, in England.

In speaking of the Whitworth establishment at Manchester as unique, and of the process of manufacture at that place as a revelation, reference is specially made to the operation of forging. As to the assorting of ores, and the treatment of metal in the furnaces, there is no intention to draw distinctions; but as to the treatment of the metal after casting, there can be no doubt of the superiority of the system adopted by Sir Joseph Whitworth over that of all other manufacturers in the world. The process here adopted has been kept singularly exempt from scrutiny. Even in the offices of the chiefs of artillery there can be found no information, within the knowledge of the board, which is at all satisfactory upon the subject. Whatever knowledge there is seems to come from hearsay—none from personal observation; and it is only from personal observation that the merits of the system can be fully appreciated.

The system of forging consists in compressing the liquid metal in the mould immediately after casting, and in substituting a hydraulic press for the hammer, in the subsequent forging of the metal.

The flask is made of steel, and is built up of sections united by broad flanges bolted together in such numbers as to accommodate the length of the ingot to be cast. All moulds are cylindrical in form. The interior of the flask is lined with square rods of wrought iron, longitudinally arranged, which form when in place a complete cylindrical interior surface. Where the square edges of these rods meet they are cut away, both on the inside and on the outside, and, at intervals of two inches, small holes are drilled through between the rods, forming a channel way from the interior to the exterior for the passage of gas and flame. The interior is then lined with moulding composition. The flange at the bottom of the flask, as well as that at the top, is perforated with small holes which act as a continuation to the perforations between the segments of the lining for the escape of gas.

The casting is made directly into the mould from the top. On the completion of the casting, the mould is moved (by means of a railway at the bottom of the casting pit, which is a deep trench running parallel to the position of the furnaces) to a position under the movable head of the press, which is allowed to descend until the top is in contact with the metal in the mould, and in this position it is locked; a shower of metal is induced, which ceases almost as soon as commenced, by the complete closing of the mould. The first impress felt by the metal is due to the weight of the head of the press alone. This pressure is gradually increased from below by hydraulic action, applied by four rams upon the table on which the flask rests, until the pressure exerted amounts to 6 tons per square inch. The interval from the commencement of the pressure until the maximum is reached varies with the size of the ingot, being for a 45 ton ingot as much as 35 minutes. During this time the flow of gas and flame from the apertures in the flanges of the flask, at top and at bottom, are continuous and violent, exhibiting the practical effect of the compression. This pressure is applied by the direct action of steam and pumping engines, and is indicated by a dial. At the end of this time the pump is taken off, and a uniform pressure of about 1,500 pounds per square inch is established by attaching an accumulator to the press, and allowed to remain until the metal is sufficiently cooled to insure no further contraction in the mould.

The contraction in length in the mould during the action of the pump, while the maximum pressure is being reached and sustained, amounts to one-eighth of the length of the ingot. After this effect has been produced, there is no farther advantage derived from the pressure in the way of eliminating impurities, but the contraction, in cooling, still goes on, and the pressure by the accumulator is considered necessary in order to follow up the metal as it contracts, for the purpose of preventing cracks being inaugurated at the end and on the exterior of the ingot by the adhesion of particles of the metal to the sides of the mould.

When cooled and reheated, the ingot is brought under the influence of the forging press. This press is hydraulic, with a moving head having the main hydraulic cylinder fixed in it, and it is provided with an arrangement of mechanism for raising and lowering the moving head of the press and for locking the same in any desired position. The press has four hollow pillars screwed part of their length, which are attached to the base of the press by nuts. On the top of the pillars is fixed a cast iron head or table supporting two hydraulic lifting cylinders, the rams of which are fitted with cross heads carrying four suspension bars. These bars pass through the moving head, and are connected at the lower ends by cross bars, which are fastened to the pressing ram. The moving head works between the base and the top or fixed head of the press, and is raised or lowered by the admission or exit of water from the under side of the rams of the lifting cylinders. The moving head can be firmly and rapidly locked at any height from the base which may suit the work to be operated upon. The moving head, as already mentioned, carries a forging or compressing cylinder, which forces a ram down upon the work. By attaching the compressing cylinder to, and making it part of the moving head, a short stroke can be employed when forging objects which may vary in size from a few inches to several feet in diameter.

This in general terms explains the working of the ram. The effect produced by it requires to be seen in order to be thoroughly appreciated, and is altogether different from that produced by the hammer. The heated ingot resists the blow of the hammer, but the insinuating, persevering effort of the press cannot be denied. The longer time (several seconds) during which the effort lasts is a great element in its successful effect. As pressure succeeds pressure, the stability of the particles is thoroughly disturbed and a veritable flow of metal induced, which arranges itself in such shape as the pressure indicates; the particles are forced into closer contact, and the whole mass writhes under the constraint which it is impotent to resist.

The board witnessed the operations of casting followed by that of liquid compression, the enlarging of hoops, the drawing out of cylinders, and the forging of a solid ingot. The unanimous opinion of the members is that the system of Sir Joseph Whitworth surpasses all other methods of forging, and that it gives better promise than any other of securing that uniformity so indispensable in good gun metal.

The latest exhibition of the wonderful character of the Whitworth steel has attracted great attention, and may be stated as indicating the present culmination of his success. From a Whitworth 9 inch gun, lately constructed for the Brazilian Government, there was fired a steel shell which, after perforating an armor plate of 18 inches of wrought iron, still retained considerable energy. The weight of the shell was 403 pounds, the charge of powder 197 pounds, and the velocity about 2,000 feet. The shell is but slightly distorted. The tests of the metal of which it was made show a tensile strength of 98 tons per square inch and a ductility of 9 per cent.

A New Light.

At the last meeting of the Physical Society, some "Lecture Experiments on Spectrum Analysis" were shown by Mr. E. Cleminshaw. The chief point in these experiments was the production of a brilliant light without the use of the electric arc. A small quantity of a solution of the salt to be experimented on is put into a flask in which hydrogen is being evolved by the action of zinc upon dilute sulphuric or hydrochloric acid; the bottle is provided with three necks, one being fitted with an acid funnel, one with a jet, and by the other is introduced a current of coal gas, or better, of hydrogen, by which the size of the flame can be increased and regulated. The jet, which is about one-eighth inch diameter, is surrounded by a larger tube, by which oxygen is admitted to the flame, the result being a brilliant light giving the spectrum of the salt substance, which is carried over mechanically by evolved hydrogen. The spectra of sodium, lithium, and strontium were shown upon the screen; and the absorption of the sodium light by a Bunsen flame containing sodium was clearly seen.

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