SUBTERRANEAN LONDON.

(See page 356.)

The cuts which accompany this article will give our readers some idea of the various works which are effected beneath London. And now that they are ready and in operation, people find it difficult to comprehend how it was possible to pass so long time without them. They have cost much money, but the subterranean railway is a lucrative enterprise ; and if the other works are not of equal profit, the facilities which they offer to the multitudes who inhabit the great capital of the world are certainly worth the money they have cost. Of these works the principal, as well as the first projected, is the Metropolitan Subterranean Railway. It was projected about the year 1860. To the capital stock of the company, which proposed to execute it, the Great Western R. W. Company subscribed £200,000, on account of its accession to its traffic in the centre of the city ; and the city of London subscribed an equal sum.

On the 10th of January, 1868, the permanent way was opened for the transportation of passengers between Paddington and Farrington Streets. At first, the directors of the Great Western Railway took the management of the line ; but after the 10th of August of that year it was worked by the Metropolitan Company.

This subterranean railway has had a grand success. In the first year there were transported on it nearly 9,500,000 passengers. Two years later the number of passengers annually transported was almost doubled, and now, the line making almost the entire circuit of the city, about 50,000,000 persons avail themselves each year of this means of transit from one part of the city to another. On working days 350 trains make the round of this line ; and on Sundays 200. So complete and perfect is the system of signals used to give exact notice of the respective positions of the various trains, that they can be despatched with entire security at intervals of two minutes.

To the mind of one not having seen this subterranean tunnel, the question would naturally suggest itself whether the passengers of this line are not subjected to many inconveniences in travelling thus in a dark tunnel and breathing the gases generated by the fires of the engines. These fears have, however, no foundation. The cars are lighted with gas carried in rubber bags in wooden cases, and fastened to the roofs. The bags are subjected to the pressure of a weight, and thus the gas is conducted to all parts of the car, furnishing a brilliant and safe light. An index always shows what quantity of gas is contained in a bag, and when it is necessary to refill the bags, it can be done at the terminal station in two or three minutes.

The locomotives are light and powerful machines, made so that the steam does not escape in the stack, as in ordinary locomotives, but condenses in tanks attached to the sides of the engine, and which contain 4,500 liters of water, a quantity sufficient for the going and coming of the train. The fuel is coke, prepared especially for this line, and so coked as to give no sulphurous gases. And there is none in the subterranean line in all its extent ; a great part of it is, and especially at the stations, open to the light of day.

The first-class "coaches" carry ninety passengers each, those of the second-class eighty and more.

The traffic on this railway is regulated so systematically that at the terminal station, called "Mansion House," where ground is so dear that the space belonging to the company is very limited, having place for only three platforms and three lines of rails, three trains have entered the station, discharged their passengers, taken others, and been supplied with gas, all in the space of six minutes. In this station thirteen trains come and go each hour from eight in the morning to eight at night.

The first of the four cuts represents in transverse section the works constructed beneath one of the streets of London. Here we see, first, the concrete foundations for the sewers and for the gas and water pipes and telegraph wires ; one also sees the galleries, the means by which they are ventilated, and the means adopted to prevent the noxious gases generated by the decomposition of the sewage materials from rising to the surface by the pipes which conduct the rain water from the street by the subterranean galleries, and one sees also the system of paving adopted on many of the streets of the city. There is first a layer of brick ; above that another of coarse stones ; this is covered by another layer of concrete made of hydraulic lime and fine gravel ; and above all this is placed the pavement of granite parallelopipedons.

In Fig. 4 the upper railway is part of the Metropolitan Railway, and the lower is part of the Midland and Great Northern. When we flect that the upper line is thirty feet below the surface of the ground, we will understand that truly it is one of the greatest works of engineering to construct a railroad at a still greater level. And this only a part of the grand enterprise which offers so great convenience to London, and which now appears almost absolutely necessary.

Fig. 2 represents Kings' Station, where, besides part of the principal line, one sees part of a branch. Of these there are so many that there are very few places in all the great city of London (containing few less than four millions of inhabitants) that have not easy access to one or the other of the many stations of the subterranean railway.

Fig. 3 shows part of the raifroad, and besides this some of the greatest of tho subterranean works, which are one of the glories of London. It represents a section of the famous Thames tunnel. When the subterranean railroad passes by this tunnel, its roof, in place of being of a semi-circular section, as in the other subterranean parts, is formed of straight iron beams, placed transversely eight feet apart in the spaces between them. The roof is of brick in a low arch.

In gallery 1, which is nine feet in height, we find the gas and water pipes, and the telegraph wires. In the first cut we see that in some other parts of the city these galleries are much more elaborate. They are easy of access, having many places for entry ; at a slight distance apart are iron gratings in the top, to permit daylight to enter, and where it is not possible to have these gratings, the galleries are lighted by gas.

2 shows a sewer conduit. Of these there is in the whole city an immense net work ; being in total extent at least 1,300 miles or 2,001 kilometres. The section of the greater part of the galleries is circular, of the rest, elliptical. The smaller ones are four feet in diameter ; the larger measures twelve feet in height, and nine and a half in width. The thickness of these walls, which are made of brick and cement, varies from nine and a half to twenty-seven inches.

In the construction of the sewerage works of London were employed 818,000,000 bricks and 180,000 yards of concrete ; there were removed 3,500,000 cubic yards of earth ; and the cost was £4,100,000. The total force of the steam engines employed to work the pumps is numerically 2,380 *HP.*, and they consume annually about 20,000 tons of coal.

To give an idea of the means employed to conquer the difficulties encountered in the construction of this work, we may mention only the grand aqueduct of wrought iron, with a span of 150 feet, and which weighs 240 tons, which conducts the sewage stuff from above the Metropolitan Railway to Farringdon Street.

4 of Fig. 2 shows the tubes of the Pneumatic Railway, the company of which was organized in 1868, with the end of uniting various parts of the city by tubes, and transmitting through them, by air pressure, letters and small packages. It united also Euston square and the General Post Office, at High Holborn, where the principal station was. But the enterprise was not very successful. After an experience of 18 months it was evident that it would not give a reasonable profit, and it was abandoned.

The tubes, however, were in their places, and being below the tunnel of the railroad, they were employed, with the pneumatic machinery, which had served to transmit the letters, to ventilate a part of the tunnel where formerly the air had been very vitiated. But it is not at all improbable that the time is not distant when the pneumatic system will be an accomplished fact, with a basis as secure as now steam propulsion has.

[The foregoing is translated from the Portuguese of the *Revista Industrial ;* to which we acknowledge our indebtedness for the engravings.]—*Polytechnic Review.*

THE COSSACKS AND SCIENCE.—An English writer shows how the Cossacks may apply science in the present war, as follows : "In a belt around their wastes they carry a few pounds of gun cotton or dynamite, and with this highly destructive explosive they may work incalculable harm. A small charge of gun cotton placed singly upon rails and fired with a fuse suffices to blow several feet of the iron to a distance of many yards, thus rendering the railway unserviceable on the instant. A trooper may dismount, place a charge at the base of a telegraph pole, fire it, and be in his saddle again in the space of 60 seconds. Wires may thus be cut and communication stopped in the heart of an enemy's country by fearless riders, while the lines of railway are entirely at their mercy. Even light bridges and well built stockades may be thrown down by violent detonations of compressed gun cotton, and forest roads considerably obstructed by trees thrown across, which are never so rapidly felled as when a small charge of this explosive is fired at their roots.