ANTWERP WATER WORKS AND USE OF SPONGY IRON FOR FILTERING.

At the eighth Meeting of the Session of the Institution of Civil Engineers held on Tuesday, the 16th of January, Mr. James Brunlees, F.R.S.E., President, in the chair, the Paper read was on "The Antwerp Water Works," by Mr. William Anderson, M. Inst. C.E.

The Author commenced by stating that in 1879 the concession for the supply of water to the city of Antwerp fell into the hands of his firm. Antwerp had a population of 200,000 inhabitants; it ranked as the third largest port in Europe, and was being rapidly extended and embellished. Previous to the construction of the works the water supply was derived from shallow wells and open canals. As the sewage arrangements were very imperfect, the well water, though clear, bright, and sparkling, was for the most part dangerously contaminated. The scheme adopted by the Author's firm, the only one practicable from a financial point of view, was originally suggested by Mr. J. Quick, M. Inst. C.E., and consisted in taking the waters of the river Nethe, an affluent of the Escaut, at a point 11 miles from Antwerp, where it was crossed by the Malines Road. The waters of the Nethe were, however, quite unfit to compete with the existing supply, after only ordinary filtration through sand, because they were greatly coloured by peaty matter, and very finely suspended mud, which could not be separated either by subsidence or filtration. Moreover, there would have been great risk in introducing into an important town, water from a river which flowed through a highly cultivated and populous country; and the attempt to supply Antwerp from the Nethe would probably never have been made had not Professor Bischof's process of filtration through spongy iron come under the notice of the Author. The properties of finely divided metallic iron as a material for filters had, for some time, attracted the attention of chemists. Professor Bischof, Dr. Frankland, and Mr. Hatton had demonstrated that it possessed the power of destroying organic impurities, removing colour, separating finely suspended matter, softening, and above all, destroying the germs of putrefaction, of bacteria, and probably those of epidemic diseases. To confirm the evidence afforded by laboratory experiments, and by spongy iron domestic filters, which had been in use for some time, it was determined to carry out experiments on a large scale at Waelhem, the proposed site of the intake of the works, under the auspices of Mr. Ogston, Assoc. Inst. C.E. The arrangement recommended by Professor Bischof took the form of a pair of filters, having an aggregate area of 680 square feet. The first filter was to be placed on a higher level than the second, and to be filled with a bed of spongy iron and gravel, mixed in the proportion of one to three, covered by a layer of ordinary filter sand, the office of which was to separate the grosser suspended matter. In this filter the water would become charged with iron, to eliminate which it was to be exposed to the air, and passed through a second or ordinary sand filter in which the red oxide would be deposited. The experiments were carried on for three months, and proved so satisfactory that all doubts about the efficacy of the process were removed, and the designs were made for the permanent works.

The terms of the concession required a daily supply of 33 gallons per head for 175,000 inhabitants, or nearly 6 million gallons per day; but, in the first instance, the pumping machinery and main were to be laid down for only 40 per cent. of that quantity. The works consisted of a 42-inch intake pipe, two settling ponds of an aggregate capacity of 2,640,000 gallons, a pair of Airy's screw pumps, worked each by an independent engine, for raising the settled water 19 feet into the spongy iron filter beds; three spongy iron filters having an aggregate area of more than 31,000 square feet, three sand filters of the same area, two cast iron filtered water tanks, containing together 340,000 gallons, and two pairs of beam pumping engines of 170 H.P. each, together with their boilers and fittings. The Nethe being a tidal river, carrying up the drainage of Malines on the flood and bringing down that of the villages on its upper waters on the ebb, the authorities prescribed certain limits within which alone the waters should be taken; these restricted the time available for filling the settling ponds to about three quarters of an hour in each tide. The settling ponds, of a capacity to hold twelve hours supply, were excavated immediately in rear of the river bank and lined with dry stone pitching. The nature of the ground was exceedingly treacherous, a bed of water-logged silt extending under the whole area, at a depth of 6 to 7 feet below the surface; it was thought prudent, therefore, to construct the filter beds entirely of earthwork resting on the surface, and to trust to puddle linings to secure the necessary water tightness, and to adopt pile foundations for the engine house and chimney.

The environs of Antwerp being very flat did not permit of a high service reservoir being constructed, the filtered water-tanks were, therefore, placed close to the engine house, and the service was maintained by uninterrupted running of the engines, which, for this purpose, were arranged in pairs, each pair coupled at right angles, so that they could run at any speed between 1½ and 22 revolutions per minute. To provide against the effect of frost, the novel expedient was adopted of heating the water, as it flowed to the screw pumps, by means of injected steam, the Author stating that the experience of last winter seemed to indicate that the arrangement would prove efficient.

The result of eighteen months working had been very satisfactory, the water having remained pure, bright and clear throughout the time. The spongy iron had not shown any signs of deterioration or wasting; and Dr. Frankland, who had visited the works, had reported very favourably of the process employed, not only with respect to the chemical condition of the water, but also with reference to the complete destruction of bacteria and their germs.

The water from the pumping station was carried in a 20 inch main for 10 miles along the Malines Road; its course was described at length, together with the appliances for getting rid of air and of avoiding dangerous shocks. The distribution of subsidiary mains and service pipes in the city was explained, together with the manner in which the various services were laid on. By the system adopted a constant circulation was kept up as far as possible in the distribution pipes throughout the city. It permitted a ranges of pipes to be shut off without stopping the supply of the neighbouring streets, and even often enabled the service to be kept up when portions of one of the mains had to be shut off. A comparison was instituted as to the relative cost of German and English pipes. The manner of testing, as fast as the pipes were laid, was described, and the Paper concluded with the statement that the works were erected in fifteen months, at a cost of £280,000.

ON GOVERNING ENGINES BY REGULATING THE EXPANSION.

BY WILSON HARTWELL OF LEEDS.

(*Concluded from page* 50.)

Perfect governing.—Perfect governing with automatic expansion gear is illustrated by Fig 7, Page 49. The full line on the lowest third of the diagram indicates the load, that is, the mean pressure on the piston which would exactly balance the load: this may be called the independent variable. The dotted power-line running beside it shows the actual mean pressure on the piston, or the power. It is obvious that the spaces enclosed between the zero line and the load line, and between the zero line and the power line, will on the average be equal to each other, as illustrated by the horizontally and vertically shaded spaces. *When the load is in excess, the speed and the* position of the governor will fall. When the power is in excess, the speed and the position of the governor will rise. The diagram is merely illustrative, and not quantitative. Thus the load is supposed to rise suddenly from 3 to 4, and simultaneously the speed of the engine, the position of the governor, and the mean pressure on the piston begin to vary, until the power rises to balance the load. The speed then remains uniform, but rather slower. This is shown by all the lines changing to position 4, and remaining there. The horizontally shaded space represents the power given out by the fly-wheel. Further on the load is supposed to fall to 2, and the speed to rise to 2. The vertically shaded space then represents the power absorbed by the fly-wheel.

Retardation from storage.—This is illustrated by Fig. 8, Page 49. The load is supposed to vary from 2 to 4. The speed line falls from 2 to 4, and the governor line does the same; but owing to the storage the mean pressure or power line does not simultaneously rise to line 4. The speed therefore continues to fall, say to line 5, and the governor, instead of remaining at position 4, falls to position 5, thus putting on too much steam. The speed will then begin to rise again until too much steam is shut off; and in consequence several oscillations of speed take place without any further change in the load.