NOTES ON SOME IMPORTANT PORTIONS OF MELBOURNE SEWERAGE SCHEME.

Read before the Victorian Institute of Engineers, by Mr. KAUSMAUL, 4-10 95.

MR. PRESIDENT AND GENTLEMEN.—In compliance with a request that I should read a paper before the Institute, I have much pleasure in submitting to you now, some notes on the Melbourne Sewerage scheme. The subject as a whole, is not a new one, for it has been treated and described in various lectures and papers, as well as in articles published from time to time in daily and weekly journals. I may, therefore, assume that the members are sufficiently acquainted with the general outlines and principles adopted by the Metropolitan Board of Works, at the recommendation of their Engineer-in-Chief, Mr. Thwaites. However, I think a short recapitulation of the cardinal points and works may not be out of place to introduce my subject—“Notes on some important portions of the Melbourne Sewerage Scheme, already finished or in course of construction.” The method adopted here for effecting the speedy removal of principal matters liable to decomposition, is called the Water Carriage Separate System; rainwater with a few exceptions is excluded from the sewers. The sewage is to be disposed of by irrigation and downwards filtration of the sewage farm at Werribee, the purified water is to flow into the sea. The scheme provides for a future population of one million. The assumed quantity for the calculation of sizes of main sewers is 30 c. per head per day, which is equal to 75 gals. or 12½ c. for 12 hours, plus an allowance for rain-water, which cannot be excluded. The gradients, with a few exceptions, are designed to give a velocity of not less than 189' per minute when running half-full. The various works of such a system may be divided into three distinct operations:—(1.) The works of collecting the sewerage; (2.) the work of pumping and carrying on; (3.) the works of disposal of the sewage. As it would be impossible to deal with all in one evening, I shall confine these notes to the works of the second division, which includes the outfall sewer with its aqueducts, and the pumping station, but exclusive of machinery. The outfall sewer carries the sewage by gravitation to the place of disposal—the sewage farm. After it has been forced by pumps through the rising mains 1½ miles long, to the highest point of the outfall sewer, about 65' above L.W. mark, the sewer is a canal of about 16 miles in length, with a constant fall of 2' to the mile. It is circular in section, with 11½ clear diameter, partly open, partly covered, that is in the deeper cuttings as well as under road and railways, the full circular section is carried out. In the other shallower portions only the lower half, the upper half to be completed at some future date. The permanent lining consists of either brickwork in cement, 4½' thick, on cement concrete foundation, about 9' thick, or of concrete or of brickwork only, both 13½' thick, except where the excavations are in rock. Where the invert level is above the natural surface, the sewer rests on rough rubble masonry, with an embankment on each side. In the covered portions, manholes and ventilation follow each other in succession, about five chains apart. The manholes are provided with step-irons for access to sewer. The surplus material from the excavation is deposited along the line on one side, a portion of which will be used for filling over the future upper-half, not yet constructed. A fencing is erected all along the line two chains apart, to protect it. The sewer, on its way to Werribee crosses, besides a good many important roads and one railway, three well defined river valleys, namely, that of Kororoit Creek, that of Skeleton Creek, and that of Werribee River. The method of crossings generally adopted, is either by means of a syphon or by means of an aqueduct. The latter method was preferred:—1. On account of the much more economical maintenance as compared with that of a syphon. 2. Because it also offers the possibility of laying a roadway across the bridge, a point which may
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become of great importance for the future construction of the upper part of sewer, in carrying goods and materials along the line. The type is the same for all three aqueducts. It consists of a number of brick arches 42 inches span each, supported on a number of 9' 6" diameter, of considerable magnitude, THE PUMPING STATION the collecting place of the whole sewage of the metropolis. The locality chosen is situated at the S.W. corner of the sewage farm; it offers many advantages not easily found elsewhere. The plan of the present structure, before the final design of the aqueduct was proceeded with, consists of rough rubble masonry to avoid any settlement whatever of the sewer foundation; a brick lining 5' 6" high with impost course is used from below, for the same reason a plaster 2' 3" wide is carried right up to the top of the parapet walls over the immediate piers, breaking the somewhat monotonous front elevation of the walls, at the same time contributing to their stability. The end abutments 28' wide across, allowing of a roadway of 23' 6" between the parapets, are of various lengths, according to the height of the adjoining embankments; the sewer under is circular in section with a filling over. The foundation consists of rough rubble masonry to avoid any settlement whatever of the sewer tunnel in that portion. The change from the circular to the U shaped section, along the aqueduct (between the abutments) is formed gradually in order to prevent any deferring of the flows. The whole of the visible faces of all concrete work is rendered in cement 3" thick, with cement wash to obtain a smooth surface all over. THE BRICKWORK FOR THE ARCHES was designed with radiating joint right through, but this was only carried out to at the faces, the interior having been replaced by a number of concentric brick rings 3½" thick; an alteration which seems to have been more convenient for practical reasons, and equally good for such flat arches. Before the final design of the aqueduct was proceeded with, comparative estimates of cost were made with arches of 27', 35', and 40' span, and it was found that the type adopted was the most economical for the particular average height of about 38' 0 from invert level to foundation level in each aqueduct. The calculated pressure in the brick arch under the parapet wall, amount to 170 lbs. at the crown and nearly 200 lbs. pro, 4" at the springing. The foundation in all cases, is on good solid rock. Other objects of some importance along the line are the inverted syphons under and across the sewer, to carry rainwater from the higher to the lower side; they are all built in cement concrete of the barrel shape. The highest point of the outfall sewer is connected with the three future rising mains of wrought iron 60 in diameter. This junction is carried out in concrete and brickwork, the end of the rising mains lead into 3 separate channels of the same diameter which run for a short distance parallel and gradually changing from 3 into the one of the outfall sewer. A brick building 40' wide, 52' long, is erected covering the whole junction, and providing sufficient space to execute some methods of disinfecting the sewage, if required. The roof trusses of wrought iron with pin joints and forged eyes are 25' 6" apart, and carry the wooden parings with slate roof on close boarding. I now come to the second portion of my notes, which is in considerable magnitude, THE PUMPING STATION the collecting place of the whole of the sewage of the metropolis. The locality chosen is situated at the S.W. corner of the metropolitan area on the western bank of the river Yarra and ½ a mile north of its mouth, being part of the city of Williamstown. The point is about 11 miles distant from the northern, eastern, and southern boundaries of the area, and 19 miles from the sewage farm; it offers many advantages not easily found elsewhere. 1st. The desirable, though not absolutely necessary distance from any densely populated district, the nearest portion of Footscray being distant 1 mile, Williamstown 1 mile, Port Melbourne 2 miles, and Melbourne City 3 miles. 2nd. The easy approach by rail and by boat; by rail on a loop line already laid from Spotswood to the P.S. yard, and by boat on the river, 3rd. The favourable and exceptionally solid ground so near the river for the extensive excavation of the underground works. 4th. The comparatively low value of the land in that district. In order to explain the whole complex of buildings and structures connected with the P.S., I must first call your attention to the two MAIN SEWERS which enter the P.S. yard. The first, 9' diam. from the south, called the H. B. main; the second 8' 6" diam. from the north, called the North Yarra main, both
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terminating with a straining tank. These and the works between them form the P.S. proper divided into 3 different classes. 1st. The underground works. 2nd. Those above ground meaning, those above the natural surface which is about 12' 6" above L.W. mark. The underground portion includes the straining tanks, the junction main between them and the pump wells, pits and connections. The working of the whole, comprises the straining of the sewage in each tank, the collecting the same into the various pump wells from the junction main, the lifting from the wells and forcing through the rising mains to the highest point of the outfall sewer, equal to a lift of about 110' from the southern wells, and 102' from the northern wells. The straining tanks for each main sewer are constructed to prevent all large floating bodies from passing into the pumps. They are circular in section 22' clear diam., entirely built in cement concrete. The depth of the southern tank being 57' 6", and that of the northern 50' 6" from surface to invert level. A number of floors 12' 0" apart with cement decking on corrugated iron supported by rolled girders, divide the tanks into several flats; the straining cages, two in number, are placed into the lowest division in a line with the flow of the sewage; they consist of a wrought iron frame work with a strong steel wire netting of 1" meshes tied round 3 sides open towards the flow to allow all sewage to enter the cage and exit through the netting towards the pumps. Each floor is provided with rectangular openings, 11' x 6', to permit the cages to be lifted to the surface by means of winding engines and lifting gear; one cage always to be at the bottom in use whilst the other may be cleaned above. Iron stairs are fixed from floor to floor, giving easy access from the surface to all portions of the straining tanks. A penstock which can be lifted by hand at the first floor is fixed at the entrance of the main sewer, allowing the sewage to be cut off from passing to the wells, if by accident all pumps should have to be stopped at the same time; in this case an overflow at the height of about L.W.M. would come into action, connecting the manhole near by with the river. Leaving the straining tanks and cages the sewage is carried to the pump wells through a main sewer, 9' diam., called the Junction Main, falling from each tank towards the centre of the P.S. A line drawn from east to west at right angles to the junction main divides the whole into two equal and symmetrical portions. The levels of the junction main are at the south 45', by north side 37' below L.W.M. A short steep falling portion connects the different levels; a penstock placed into the sewer under the centre line east and west prevents the sewage running from the higher to the lower portion. The pump wells, six in number, placed on each side, and parallel with the junction main, are elliptical, 30'x15' diam., the distances from centre to centre are 30' across, 3½' 6" along the line of main sewer; the bottoms are divided into a number of channels 3' 6" below the S.L. of the main between them. The lining consists entirely of cement concrete, with cement rendering all over 2½" thick. Cast iron pipes, 3½' diam., connect each well with the main; each pipe is provided with a penstock at the well inlet. By this arrangement either one or more of the wells may be cut off, and pumped out to allow of a thorough inspection of all parts, and machinery placed in the well without in any way disturbing the working of the remaining pumps. In a similar manner either the northern or southern group of wells and pumps may be placed out of action by simply lifting the large penstock dividing the junction main to allow the sewage to flow towards the group of pumps required to be worked. The engines are placed on the flood level; the pumps into the wells on a system of rolled girders, firmly bedded into the walls. Delivery mains of wrought steel running towards the centre of P.S., varying in size from 4½' to 8½', with valves at each end, collect the sewage from each pair of pumps, and carry it on to a common receiver, 15' diam., and 24' long, and from here into the rising mains of which two are laid at present. The delivery pipes are placed into a pit, 11' 9"x14' 6", under the flood level running between the wells and parallel with the junction main; these pits lead into a large chamber under the "S. yard between the buildings, taking in the receiver and its connections with the rising mains and by pass pipes; the latter, 6' diam., with valves connecting directly each delivery pipe with one rising main to cut off the receiver when required to be cleaned or repaired. The structures above ground are the building over straining works, and the buildings necessary for the pumping machinery. The buildings over straining tanks are octagonal, 40' diam.; the walls are of brick in cement, with bluestone base on concrete.
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foundation; they are covered with a slate roof on close boarding supported on wooden rafters; they are to receive the necessary machinery for lifting the cages and cleaning them above floor level. The buildings for the pumping appliances consist of two separate groups exactly symmetrical for the northern and southern portion; they cover an area of nearly one acre, including the open yard between them; each room consists of engine room, boiler room and coal bunker; the engine room with offices annexed of two stories form the front elevation along the river; boiler room and coal bunker are attached at the back on the west side. The dimensions are, engine room, 131' x 56'; boiler room, 92' x 52'; coal bunker, 92' x 28'; the average height from floor to tension bars of roof trusses being 25' and 21' in coal bunker. The outer walls, as well as the division walls, between the rooms are of brickwork in cement with bluestone base on concrete foundation. The engine rooms extend over the six wells, allowing ample space all round between them and the surrounding walls. A travelling crane, 57' span, will be erected to run from end to end, strong enough to lift and manipulate the heaviest pieces of the machinery (about 12 tons). The boiler rooms which receive the boilers and one economiser are large enough to take six boilers ultimately. The coal bunkers adjoining the boiler rooms with a sloping floor have a storage capacity of about 2000 tons; the coal brought on the loop line along the back of the rooms can be unloaded directly into the bunkers very conveniently, for the strong shutters fitted to the openings can be lowered on hinges, fixed at their lower end, into such a position as to form a sloping shoot from the tracks to the bunker openings. The lower portion of the outer wall of the coal bunkers is also a retaining wall for the adjoining embankment. The division wall between boiler room and coal bunker is provided with large openings, 8' x 7' 6", and doors to them opposite each boiler front, to get at the coal as well as to be able to draw and exchange any boiler-tubes. The roof for each room consists of slating on close boarding, supported by wooden purlins on W.S. roof trusses of the French type 12 apart, with rivetted joints. Heavy lantern lights are provided all along the ridges from the first to the last roof trusses; the glass plates, 6' wide, 1' thick, of various lengths for each room, rest on Halliwell's patent steel bars. The rooms are ventilated by means of Halliwell's patent zinc louvres, running along the lantern lights. The weight of one truss proper, also the dead load per sq. ft. covered area for the various rooms, together with similar particulars of the roof construction for building over junction at upper end of outfall sewer mentioned before, are given in the table following this paper.

The total load, including wind for the calculation was taken to 50 lbs per sq. ft. covered area. It may be of interest to the members to know that the cost per ton iron roof construction fixed complete, was: With rivetted joints as at the pumping stations, £18 10; with pin joints and forged eyes, as used over the buildings over junction on outfall sewers, £29 10s.

The machinery immediately to be erected will be two pair of engines in each engine-room, three boilers in each boiler-room, and one economiser in the southern boiler-room. As a temporary arrangement the gases from the boiler of the northern range join those of the southern by means of a temporary collecting flue running under the P.S. yard to the economiser or main flue, thence to the chimney which will be 180' high, with a clear diameter of 8' at the top, and which is to be erected near the southern complex on the west side. The present arrangements of the P.S. and the number of wells already constructed will be sufficient for a population of about 650,000, when the necessary machinery, pumps, engines, boilers, etc. are added, according to the requirements of the scheme.
### Notes on Melbourne Sewerage Scheme

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<th>Description of Roof</th>
<th>Weight of Iron Girders and Docking</th>
<th>Nature of Docking</th>
<th>Total Dead Load</th>
<th>Per Bay</th>
<th>sq. ft.</th>
<th>Bar</th>
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The weight of the iron girders and dockings can be calculated by the given formula:

\[ \text{Weight} = \text{Length} \times \text{Width} \times \text{Thickness} \]

The total dead load is then calculated by adding the weights of the iron girders and dockings together.

### Table

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<th>Distance of trusses</th>
<th>Weight of trusses with 1/4 in. th.</th>
<th>Weight of Girders and Dockings</th>
<th>Nature of Docking</th>
<th>Total Dead Load</th>
<th>Per Bay</th>
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The table above shows the weight of trusses and girders, as well as the total dead load per bay, with the corresponding bar size in square feet.

### Additional Information

- The engine is located on the southern side of the river.
- The boiler is 92' x 21'
- The rooms are about 5' high.
- The bunkers and boilers are about 21' high.
- The engine is located on the northern side of the river.

The weight of the iron girders and dockings can be calculated by the given formula:

\[ \text{Weight} = \text{Length} \times \text{Width} \times \text{Thickness} \]

The total dead load is then calculated by adding the weights of the iron girders and dockings together.
Discussion on "Notes on Some Important Portions of Melbourne Sewerage Scheme."

The Chairman, Mr. H. V. Champion, thanked Mr. Kaussmaul for his able paper. It was well known now that the entirely separate system had been adopted by the Board of Works. All engineers interested in the water carriage system in Melbourne would remember Mr. Mansergh's recommendation that a considerable portion of rainfall was to be included in the sewers as well as to carry away the sewage of the city. Mr. Thwaites almost entirely eliminated the rainfall thereby saving a large amount to the ratepayers. It must be gratifying to Mr. Thwaites to be certain that he adopted, in carrying out the works, a system which meets with the approval of those who have made this subject a study. At the time he was subjected to considerable adverse criticism for daring to interfere with Mr. Mansergh's design. The discharge provided for was 75,000,000 gals. per day of 12 hours. Seeing that such a provision had been made (no doubt, wisely), he thought that Mr. Thwaites had acted rightly in eliminating the rainfall as much as possible. Regarding the aqueducts, most engineers would admit that the admirable designs shown, were about the best that could have been adopted under the circumstances. Syphons were always troublesome. Roads could be made over these aqueducts, which would be an additional advantage, and the ground was favourable for the construction of these works. It would be interesting to those gentlemen who had taken prominent parts in the recent discussions on roofs to note the interesting table given by Mr. Kaussmaul. The pinned roof seemed to be out of it altogether. The type of roof at the Pumping Station seemed to be after the style of Prof. Kernot's roof at Richmond, except that the girders were placed more closely in this case. One point that struck him in connection with the Pumping Station was the arrangement of the wells. That one or more of the pumps could be shut off at any time. That was an admirable arrangement whereby the sewage could be turned off altogether. It would be interesting to learn what effect would be produced on the sewers if the sewage were turned off from the Pumping Station, and allowed to flow into the river. He would like to hear members discuss this paper thoroughly.

Mr. Bilton asked if the sewage were turned into the river would the whole of the sewers fill with water?

Mr. Kaussmaul said provision had been made for overflow only, a case which would probably never happen. Should the sewers get full, they could only fill up to the level of the tide at the time. For the next 10 years it would take more than 3 or 4 hours to fill them up to low water mark.

Capt. L. H. Chase asked why it was necessary to use single rings instead of the radiating joints of the arches on the aqueduct?

Mr. Kaussmaul said he would like to hear members' views on that subject. He liked the radiating joints.

Mr. C. E. Oliver explained that the trouble was with the specification. It was optional with the contractor, and they could not help themselves. They would have had the radiating joints if they could.

Capt. Chase thought the radiating joints were much better than the others, for an arch was much in the same condition as a wall with a heavy weight on top, and no engineer would dream of building a vertical brick wall under such conditions in their vertical strips without land.

Capt. Chase asked what would be the velocity of the sewerage in the rising main for the first few years.

Mr. C. E. Oliver admitted that at first the velocity would be low, but if the 4' rising main became choked they could use the 6' main temporarily while the 4' was being cleaned out.

Capt. Chase suggested that a smaller pipe should be laid inside the 6' main and kept in use until the 4' main was required, and so prevent the possibility of...
these rising mains choking through the small velocity at the initiation of the scheme.

Mr. Kassmaul said there would be a difficulty in the main sewers in keeping them clean at first.

Mr. C. E. Oliver said that in this case they did not consider the strain of sufficient importance to alter the specifications.

Mr. Kassmaul said there would be a difficulty in the main sewers in keeping them clean; they could not without artificial means or flushing. Supposing the South Port Melbourne sewer were running 1 foot deep, the velocity would not be sufficient to keep it clean. He would deal with this subject more fully in his next paper.

Mr. W. R. Rennick asked how the solid substances which would be caught in the screens in front of the pumps would be disposed of?

Mr. Kassmaul said they would erect a destructor at the pumping station, and it would be burnt. Experience showed that there would be only a few cart-loads a day.

Mr. Champion said that the amount of solid matter intercepted at the Adelaide (S.A.) Sewerage Farm was very small. It was carted away and buried.

Capt. L. H. Chase remarked that at the Birmingham sewage system, the water was first precipitated through big tanks; it then ran away and had to go underneath a tunnel. The well in that syphon was the most filthy place he had ever seen. Lime was the precipitant method used.

Mr. A. E. Phillips said that it was satisfactory to note that Melbourne would shortly enjoy one of the best sewerage systems of the world. He would like to ask how long it would be before some parts of the city would be coupled up to the system started?

Mr. C. E. Oliver assuming that the river tunnel was finished, he would make connections with Port Melbourne within 6 weeks.

Capt. L. H. Chase, in reply to Mr. Champion, said that there was a considerable swell arising from the well at the Birmingham pumping station.

Mr. C. E. Oliver said that they would not get a worse swell than from the ordinary storm water channels.

Mr. C. E. Stone asked what was the ratio of the heating surface to the economiser in the boilers.

Mr. Kassmaul thought it was rather premature to say anything about the machinery until it was erected. He would, however, try and get the information asked for in the next paper he would read on the subject.

Mr. C. E. Oliver said that with regard to Mr. Champion's remarks re the rainfall, that Mr. Mansergh was not wedged to the provision for rainfall.
Discussion on "Notes on Some Important Portions of Melbourne Sewerage."

(Continued).

Mr. Kussmaul explained, in reply to questions, that the 18' rising main would be used first. A velocity of 100' per minute would require a pipe of 36" with one engine working. If two engines were working they would require a pipe of 48'. The velocity of 100' per minute would keep the pipes clean. As they would not have enough stuff for two engines at the start, they proposed to intercept some of the existing storm water channels with their sewer for the present.

Professor Kernot believed the paper they were discussing was the first of a number of them on the same subject. The subject of sewerage was of immense importance to them at the present time. The work had, up to the present, been carried out, so far as he could see, very satisfactorily. He believed one of the chief difficulties in carrying it out was that the contractors persisted in tendering at prices much lower than the estimates—a trouble that was not usual in engineering work. In this case the Board would get the benefit of it, as it enabled them to carry out the work much more cheaply. The principal point about the scheme was that the Engineer-in-Chief had been bold enough to depart in some notable ways from the proposal which Mr. Mansergh in the first instance advised. The scheme was as pure an example of the separate system as there was. The separate system seemed to be one that would be most efficient in action and easily kept in order. When they had sewers to carry storm water they had to be much larger than was necessary for dry weather use; but there was a danger of them fouling in dry weather. The arrangement of turning portion of the present sewerage into the new sewers at first was a reasonable one on the face of it. It seemed that all foul liquids were, at present, flowing down into the Yarra. By putting this into the new sewers at the outset there would be a sufficient amount of pabulum for the pumping engines, and a sufficient quantity of liquid to keep the pipes clean. There would, however, be a danger of road grit getting into the sewers, which would be very undesirable. The leaving of the outfall sewer to the Werribee Farm partly open, was something of a novelty, as they had generally been covered in. He presumed that eventually they would be closed in. He did not think there would be much danger from the effects of the sun. The liquid that would run down the outfall sewer would not differ very much from that which now flowed down the streets under their noses. In a recent number of the proceedings of the American Institute of Engineers there were some remarks on the "chooking up" of the sewers under the separate system. They were very encouraging. The Metropolitan Board of Works were making provision for periodical and automatic flushing of the sewers at the dead ends of the minor branches of the sewerage reticulation. This question was discussed at the American Institute, as to how far these appliances were necessary, and the general concensus of opinion was that it was quite possible to get on without them. Experiences were given of separate sewerage systems, in which very little trouble of this kind was mentioned. There were a few instances of an amusing character. A mattress got into a sewer, and in another a large quantity of clothing, both of which had to be removed.

The discussion of roofs sometime ago had led to special particulars being given of a roof in connection with the Metropolitan Board of Works. It was surprising to find the heavy dead load of 17 lbs. per sq. foot. The boarding and purlins were heavy, and a heavy lantern had to be added to these weights. So large a weight necessarily required a heavy truss. The provision, however, seemed certainly ample. It was 4 lbs. per sq. foot for 58 span, as against 1.6 lbs. for 69 span for his Richmond roof with a covering of minimum weight. The most important question in connection with these roofs was that of the wind pressure. Mr. Kussmaul gave
30 lbs. per sq. foot including wind. If they took off the 17 lbs., that would give 13 lbs. per wind pressure, which was not an excessive allowance, although he considered it was most abundant. This question of wind pressure should be cleared up. It was not many years since the Victoria Street Bridge was thought to be weak against wind and a lot of money was spent in strengthening it. He had calculated, however, that in its original form, it would have taken a pressure of 90 lbs. to the sq. foot to blow it over. Quite recently, in giving evidence before the Committee in connection with the narrow gauge lines, they were proposing to have railways of 2 gauge and had diagrams prepared of the railway stock to suit such lines from a German railway of that gauge. He had raised the question of the wind pressure in connection with these narrow gauge railways. One of the other witnesses ridiculed his nervousness on this point, and asserted that there was not the slightest danger. Fortunately, the dimensions and weights of the rolling stock were given, and he took the trouble to calculate the wind pressure it would take to blow it over, and found it to be 13½ lbs. per square foot if empty, and if loaded badly, it would overturn at a pressure of 80 lbs. per square foot. There was not the slightest necessity to have any fears about it! Though the Victoria Street bridge, which would stand 90 lbs. per square foot, needed strengthening, the question of wind pressure was in a very peculiar state, and it would be well if they had a better understanding about it. Eight lbs. per square foot, which would blow over on a vertical surface was decidedly dangerous. One point mentioned in Mr. Kussmaul's report was that the principals with riveted joints were only 2 of the cost per ton of those with forged connections. As a great many interesting works were going on in connection with the sewerage, he hoped that some excursion would shortly be arranged to inspect the same. When the Hydraulic Power Co. started operations, they took the water for their high pressure mains from the Yarra, which water was highly charged with sewage, and (to some extent) salt. After they had been working about 12 months, it was found that the corrosion in a number of the pistons of the Hydraulic lifts was simply frightful. Therefore, what would be the effect of the sewage on the parts of the pumps at Spotswood? What measures would be taken to prevent corrosion? He would like to know whether it would be a good plan to make the plungers of polished granite. It would resist the corrosion admirably, and there would be no difficulty in replacing them.

Mr. H. V. Champion said the separate system was in use on a smaller scale, in the city of Memphis, in the United States. This was an entirely separate system. In Melbourne some rainfall was to be admitted, but in Memphis it was entirely eliminated. It was a system of small pipe sewers, (6' branches. The pipes in Melbourne being 9') there were some very interesting and ingenious devices for preventing stoppages. With regard to the sewerage system and its application to various towns in Australia, a great number of the smaller towns would undertake works of this kind if the expense could be kept down considerably lower than for a large town. In Memphis, the expenses in connection with the separate system were reduced to a minimum. An arrangement was made as a substitute for the manholes, pipes being put sloping to the surface, and a little chamber of cast iron constructed, to which these pipes lead. In the case of a stoppage in the main, it was possible, after closing certain valves, to fill up the pipe to near the surface and remove the obstacle by putting this water under pressure, with a sort of pipe worked from the street surface. The idea was to do away with shafts as much as possible. In connection with the outfall sewer, it was not the first example of the kind in which the sewer was uncovered in part of its length. The Adelaide sewer was also uncovered, though it was made U shape.

Professor Kerfoot said that in the paper he had mentioned, instances were given of communication being made from the water supply mains with a valve on to the dead end sewers. The general idea seemed to be that there was not much necessity for that sort of thing under the separate system, providing they did not get such things into the sewers as petticoats and mattresses.

The Chairman, Mr. A. C. Mountain, had not had the time to read the paper thoroughly, but his general knowledge of the scheme had enabled him to follow the main principles of the same. He congratulated the Board on the skill and celerity with which the work had been carried out so far. He had had some experience, and apart from the engineering character of the scheme, the system...
DISCUSSION ON MELBOURNE SEWERAGE SCHEME.

and celerity with which the different parts of the scheme were carried out, as far as it had affected the convenience of the citizens, was worthy of all praise. He was surprised at the small amount of public inconvenience experienced in carrying out such a work. With regards to the departure of Mr. Thwaites from Mr. Mansergh's scheme, in making it more especially a separate system a reference to theEnginett's evidence given before the Sanitary Commission, would go to prove that everybody was satisfied that it was the proper thing to do. The fact of so many houses in Melbourne being furnished with baths, in almost daily use, would supply an amount of flushing fluid sufficient for ordinary purposes. Smaller pipes were more easily kept clean, as there was no such temptation, nor facility to introduce such small (4) articles as mattresses therein. As an instance of large pipes getting choked, he mentioned that they had a lot of trouble in connection with one of the storm water pipes in Little Collins street, cellars were flooded and the water bubbled up. This was caused by the complete stoppage of the 15in. pipe, which was taking the surface waters from Collins street. The stoppage was caused by a lot of twigs from a florist's shop, to which were added a few dish cloths, with a little clay etc. from the road, until at last the whole of that pipe was blocked. The idea of turning the storm-water into the sewer to keep the rising main clean, appeared to him objectionable, as it was only a temporary arrangement. Considering the character of the country through which the outfall sewer passed, he did not think there would be any danger, in a portion of the main being open. There was one point which had not been touched upon. It was a very important one, viz., as to whether any attention had been paid (in carrying out this scheme) to subsoil drainage. All engineers agreed that the drainage of the subsoil was an essential portion of any sewerage scheme. He would like to know if this question had been considered? Regarding Professor Kernot's remarks re the Yarra water, that was a matter that must not be neglected. He had experienced repeated evidences of the terrible corrosion, which the use of that foul and briny stream produced. Recently he had to overhaul the valve seatings of a valuable Worthington pump, used for the condensers at the dessicating works, it had been absolutely eaten away by the use of this water. Regarding the suggestion that an excursion should be made to the sewerage works. These excursions would be very instructive and useful, and if the Council received sufficient encouragement from the members they would soon arrange for them. If a number of the members expressed a desire to visit these works, arrangements would immediately be made, and members informed of the same. Mr. Kussmaul, in reply, said that the connection of the sewers with the storm water outfall was objectionable. It was a matter that he would deal with in his next paper. He would then point out the necessary preparations they had made to keep them clean. With regard to the wind pressure, he had followed the interesting discussions that had taken place on this subject. He had looked through any quantity of literature; and the more he had looked, the more he was puzzled. It was hardly possible to come to the right result. One German paper he read gave a larger wind pressure than the Professor had represented. He referred to a storm which occurred in Sydney; a more severe storm than had ever occurred in Germany; and it mentioned that the wind pressure around the coast was greater than in inland countries. He had taken the middle course. Five or six pounds to the square foot only meant a difference in cost of £39 in a roof of a building which cost £14,000, and for the sake of a little margin he would rather be on the safe side. With regard to leaving the rising main uncovered, the only objection was that there might be a smell arising from it. If so, they had made arrangements to disinfect it with lime or other disinfectants. The matter of the subsoil drainage was a very important question. They had no trouble at Port Melbourne, owing to the ground being very low lying. Their sewers had all run in lower low water mark; and from it to 40 feet below it. They could not subsoil there. South Yarra and Prahran were districts in which it would be necessary to have subsoil drains under the sewer drains. They must always be so high that they could lead them into the Yarra. It would not be advisable to let it run into their own sewers. The subsoil water would not be objectionable to the river. However, the matter had not yet been decided. The matter of cleaning the main sewers he would deal with in his next paper. Where
the gradients were 1 in 60, a velocity of nearly 3 feet per second would be attained, and 2½ feet per second would take away all the matter, except the Professor's mattresses and petticoats.

The Chairman thought there could be no doubt that he had a very easy task in proposing a vote of thanks to Mr. Kussmaul for his interesting paper. There was no doubt that the subject was one of particular interest to a great number of people in this colony. Architects and engineers all had an interest in it. They would also be glad to hear Mr. Champion's address on drainage to isolated dwellings, as very little had been done in that way up to the present.
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