Lastly, the disuse or nonuse of lands or houses should be rendered a costly luxury by discontinuing to offer a premium to the speculator waiting for a rise in the shape of exemption. Land which is deliberately rendered unproductive should be coaxed back into the domain of usefulness by making it a burden to the possessor. This can readily be done by assessing all lands at their value for use irrespective of improvements which would amount to the exemption of improvements from taxation and give the greatest incentive to industry and progress.

SECTION II.

ENGINEERING AND ARCHITECTURE.

ADDRESS

By Prof. T. ROGER SMITH, F.R.I.B.A.

PRESIDENT OF THE SECTION.

"BATHS."

The Queen of Watering-places hospitably receives the Sanitary Congress this year; accordingly some topic growing out of the material circumstances which make life at a watering-place so different in its conditions from life in an ordinary town, seems not inappropriate as the subject of the address which I am to have the honour of delivering before the members of the section of Architecture and Engineering.

There is ample matter for both the architect and the engineer to deplore to consider and to improve, as there is also much that may be recognized as admirable, in the Architecture and the Engineering of our health resorts. But I do not propose to attempt a critical examination of all this, but rather to deal with a more compact and manageable topic, and one which has the advantage of carrying part of the benefits of a watering-place to our own homes and our own neighbourhoods. I will therefore ask you to consider, during the time at our disposal, the subject of Baths, especially such baths as may be accessible to the people.

A general and well-founded impression prevails that the Romans were skilled in the construction of baths. Indeed, in most places where Roman remains exist, some traces of a bath are to be found; but the practice of the Romans was so

remarkable, and the public baths, or Thermæ, erected in Rome during the Empire, were such wonderful structures that it is worth our while at the outset to direct our attention to them; the more so, as my argument will be that it is our duty at the present day to try to accomplish for the inhabitants of our towns and cities, though in an entirely different way and by means widely dissimilar, the same result which those vast and lordly structures accomplished for the citizens of Rome.

The Roman Citizen, even if he was a poor and mean man had access to the conveniences, appliances, comforts, and luxuries of the Thermæ. Part of that which he there found our citizens dispense with; but that part with which we have to do to-day—the means of promoting health by bathing—remains in too many cases as yet out of the reach of our people.

On the sanitary value of the bath and of bathing it is hardly my province to enlarge, but I must not pass it over without a word. No part of the human body is so accessible as the skin, and its great extent and intimate relation to all other parts of our organization alike point it out as requiring care. The ailments which are due to a chill disturbing the functions of the skin are perhaps the most numerous of all to which we are subject in this country, and not the least deadly; and they are to no small extent preventable by the habitual use of the bath, and to a considerable extent curable by its means. The vast group of rheumatic and gouty complaints, if they yield to anything, yield to baths properly applied; but beyond all this, general health seems largely dependent upon cleanliness, and habitual neglect of the bath is not only contrary to our notions of self-respect and decorum, but is insanitary. The skin cannot perform its functions properly when it is not cleansed, and if the skin be out of order, every part of the animal economy suffers more or less.

To return, however, to the Roman Thermæ, they were vast establishments each wonderful both for extent and completeness. Each of them was the gift of an individual emperor to the nation. They stood in different parts of Rome. They were accessible to the citizens, and at an extremely small price: at one time half a farthing (a quadrans) seems to have been the charge. They may be looked upon as having been political bribes on a gigantic scale, as it was in order to secure the favour of the mob that they were put up. Professor Aitchison, in his lectures last year before the students at the Royal Academy, gave the most learned and complete account known to me of the Thermæ; and he has with great kindness enabled me to exhibit some of the illustrative plans and drawings which he prepared, and in part of what I am to say about the Thermæ, I shall have to remain a debtor to the published report of his lectures.*

The Thermæ combined provision for various descriptions of public occupation and amusement—such as athletics, public lectures and discussions, games, libraries and picture galleries, with the most complete system of baths possible. How various the sorts of bath (not to speak of the other departments) were, may be well stated in Prof. Aitchison's words. The Thermæ included "cold, tepid, warm, hot, vapour, and swimming baths, and possibly hot-air baths as well. To some of these baths fresh, sea, and mineral waters were supplied. In the baths people were oiled, scraped, shampooed, shaved, plucked, singed, pumiced, and perfumed, and in them they sometimes took refreshments, and seemingly on occasions dined there. There were reservoirs for the water, shops or lodgings in the peribolus, and barracks for the vast army of slaves that attended to the bathers, the baths, the furnaces, the reservoirs, the gymnasia, the palæstra, and the grounds. Workmen to repair and foremen to direct were probably resident there, and there certainly must have been vast stores of wood and pitch for the fires, stores for oil, towels and strigils, possibly even rooms for washing and drying the towels; and when the baths were kept open of a night and lit up, this must have required stores for the lamps and places for cleaning and trimming them."

The general disposition of one of the most complete of these great establishments was as follows:—A vast space, usually nearly a square, was enclosed by walls and by buildings of moderate height. In this quadrangle, but so placed as to leave much of the enclosed space unoccupied, was planted a compact block of lofty and magnificent buildings, consisting of vaulted and domed halls and baths of great solidity and beauty, combined with buildings for gymnastic exercises, all grouped together with great skill and art. In these structures the work of the bath was carried on, while the outer range of low buildings consisted partly of shops, partly of accommodation for slaves, partly of buildings for other purposes, and partly of water-tanks and cisterns.

We will take the baths of Caracalla as an example, because they are the best preserved, and they have been very fully investigated and illustrated. The rectangular outer enclosure had a frontage of 1108 feet, or within a trifle of one-fifth of a mile, with a depth slightly less, namely, 1060 feet, and a large

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* I am also indebted for the loan of illustrations, or for information or both, to Mr. Phéné Spines, Mr. C. C. Walker, Mr. Palmer, Mr. E. A. Reynolds, Mr. George Jennings, Mr. C. H. Rosher, and other gentlemen.

additional piece of land was occupied by water-tanks. These Thermæ took up, with their reservoirs, 31¼ acres.

The main group of buildings covered slightly more ground than the Houses of Parliament, including Westminster Hall, and though in quite a different style of architecture was fully as elaborate and costly.

At each end of this main building there was a gymnasium, that is to say, "exercising places for the citizens, which probably included schools for learning the various exercises and sports," here also were halls and cloisters where lectures and discourses were delivered, and libraries. The two gymnasia were exactly alike in plan, each had a large open quadrangle in its heart, surrounded by a cloister or arcade, and to each was attached a group of baths.

The central part of the building contained the great baths, it had two entrances, and between them the noble piscina or swimming bath. Beyond lay, in the very heart of the block, the tepidarium or warm hall, a splendid vaulted hall, 180 ft. long, 79 ft. wide, 108 ft. high to the vault, and with a chamber 79 ft. by 56 ft. at either end, the three making a group 292 ft. × 79 ft. The dimensions of course must fail to convey a very definite idea of such a hall, but it may illustrate their magnitude to point out that the main hall with *one* of the subsidiary ones, was about equal in length to the central hall of the Law Courts, and more than half as wide again. The three together, were both longer and wider by about ten per cent. in each case than Westminster Hall. The central hall alone was slightly larger and slightly wider than St. George's Hall, Liverpool.

This last building is the only English interior that I can name which gives any idea of the mode in which buildings such as this tepidarium were vaulted; and the richness with which they were treated does not appear to have been equalled by any modern European interior, though St. George's Hall (just alluded to) and the interior of the Madeleine in Paris, may be pointed to as examples of the same sort of architectural treatment, and indeed very possibly, both of them, more refined if very far less magnificent. I have dwelt upon the splendour of the tepidarium, as it was the noblest part of the whole, but each portion was as rich and as solid as could be. In the tepidarium it seems probable that the bathers undressed. From thence they proceeded to a hot room, calidarium, and then to the hottest room, the laconicum, a circular domed hall 116 ft. in diameter—that is to say larger than the dome of St. Paul's, but not nearly so high, with immensely thick walls, and so placed as to catch almost all the rays of the sun, and with hot-air flues under the floor and lining the walls. This, of course,

was used much as is the hottest room of a modern Turkish bath. There were other halls and rooms, the purposes of which it is not now possible to distinguish with certainty, but they were, of course, appropriated to some among the many different processes carried on in the Thermæ.

To complete a very cursory notice of this vast building, I would point out that south of the main block was a great enclosed space suitable for races and games, overlooked by a vast grand stand, consisting of raised seats, at the back of which were the water-tanks. At each end of this space was a great recessed building arranged for use in connection with these exercises. Of the furnace-flues and underground arrangements for heating, water-supply and drainage, the traces are to a large extent obliterated, but they must have been of vast extent.

What was provided in the baths of Caracalla was, with differences of detail and scale, provided also in those of Agrippa, Nero, Titus, Trajan, Diocletan, and Constantine. Ancient writers state that the baths of Caracalla could accommodate 1,600 bathers; and as, of course, persons came and went, and many went for other purposes than bathing, it seems not unreasonable to suggest that such an establishment alone would accommodate more than three times that number in the course of a day, or say 5,000 persons. When one thinks of the vast initial expense; of the army of slaves required to work each establishment and to cleanse it; of the endless provision of wood for heating the furnace and the hot rooms; and of the skilled supervision, it is manifest that such an extraordinary group of structures could only exist in a city like Rome, whose armies had overrun the civilized world and laid every country under tribute, so that vast wealth—not the produce of taxes in Rome itself, but wrung from the various subject countries—was at the disposal of the Emperor of Rome. Of this wealth use was made in a variety of ways, but I think we may safely say that there was no one municipal object to which so much was devoted as to the establishment and maintenance of public baths.

If this sagacious people attached such importance to baths for the million, is it not worth while to ask ourselves whether our attention has been sufficiently directed to this object.

We look upon ourselves, and not without reason, as having in many respects a national greatness not inferior to that of the Romans. How different is the nature of our national life from theirs, at least at the period of the Empire, may be strikingly illustrated if we ask the question how far the average British subject can enjoy the amenities which the Roman found waiting for him at the Thermæ.

The magnificent, if ostentatious, display of architecture sculpture and rich ornament has no parallel in anything English that is open to the people's enjoyment. The nearest approach was formerly made by our Cathedrals, but they have been cruelly shorn of their embellishments, and they have ceased to be places of habitual resort for the many.

In our public picture galleries the art of painting has, it is true, a means of reaching the crowd, but in displays of the other arts Roman magnificence eclipses our attempts.

The second source of popular entertainment and delight was the gymnasium, where races, wrestling matches, and all kinds of sports were to be seen, and where also amateurs had full opportunity for indulging in the exercises. Here, though our sports are more peaceful and far more humane, and the way we manage things quite different, we need not fear comparison. The crowds who throng Lord's or the Oval, the vast concourse of people at the University boat-race, at Epsom, or at Ascot, and a score of other instances, bear witness to our admiration for athletic sports. Every village green, the playing fields of every public school, our countless tennis lawns, show how keen English amateurs are in the pursuit of such exercises.

The Roman, at the Thermæ, heard the news, attended public discussions, lectures, and recitations, and so cultivated his mind. The English citizen has the advantage, whatever it may be worth, of buying for a penny the verbatim reports of Parliament of the night before, and his pennyworth includes all the news of the day from spots whence intelligence would have taken months to reach Rome; so he probably must be considered to have the best of it in this particular.

The fourth great business at the Thermæ was the one which interests a Sanitary Congress. The Roman frequented the Thermæ to keep himself in health, and for a very trifling sum had the opportunity of using a most complete system of baths arranged for that object. Has the English citizen any such opportunity, and if not, can we procure it for him? The answer to this question will occupy the rest of our time, and bring us face to face with a problem of great public importance, and one to which attention needs to be directed far more than at present.

From the baths of the Romans, it appears natural to pass to the modern hot-air bath, known by the name of Turkish Bath, in which the bather goes through a course, which is supposed, and with reason, to bear a general resemblance to what the Roman Thermæ afforded.

The true Turkish Bath, as given in Eastern cities, is a more severe and prolonged treatment than is undergone in a modern

English bath bearing that title. Prof. Aitchison's account of what he underwent in a bath at Cairo gives a complete description of what must be a somewhat formidable process.*

In an English Turkish bath the visitor first divests himself of his boots, and then undresses in a room provided for the purpose. He is then conducted into a hot room of which the atmosphere is dry as well as hot, and remains for some time till a profuse perspiration breaks out--hardy bathers venturing into an inner and hotter room. He is then shampooed, though not always with much thoroughness, he is then deluged with soap and floods of warm water, and then often has a needle-bath, *i.e.*, a bath where water is thrown upon him from a number of fine perforations. The temperature of this is gradually lowered so as to cool the bather down. Then follows a plunge into cold water, and the victim, wrapped up in towels, may then repose in a cooling chamber, and enjoy well-earned rest, with perhaps refreshment, till he is minded to dress and depart. The accommodation for all this should be all on one floor—airy, commodious, open. An ample supply of hot air and of hot and

*"I was first ushered into a vast hall lit by a lantern, with a raised seat for the bath-keeper, and a baldachino over the coffee stove, with a fountain in the middle of the hall. The whole hall was gorgeously painted, and had towels drying on the beams, which the attendants hung up and took down by means of long bamboo poles. A little above the main floor were a series of carpeted compartments, each as big as a small room. Here I undressed and wrapped myself in cloths, while my interpreter folded up my clothes and tied them up in a sheet. I was then led by an attendant across the hall into a dark passage, and was ushered into a darkish hot room where I sat on a marble seat, and I was gradually moved from room to room, each of which was hotter than the last, until I was taken into a light domed room with a central peristyle, in the middle of which was a large steaming tank of water, with steps running down into the water. The walls were lined with white marble, inlaid with coloured in patterns; the domed porticoes of the peristyle were plastered, and lit by star-shaped openings—several in each dome—the space between each arch and the wall being domed.

"Within the marble margin of the bath was a gutter. I was laid down at the side of it, rubbed with a horsehair glove, and then soaped over and scraped with a sort of artificial sponge, composed of dried grass resembling diminutive bamboo. I was then washed by hot water being poured over me from a large copper cup, and when this was finished I was made to walk down the first step and sit down with my legs in the water, which was nearly scalding. I was then made to sit lower and lower till I was up to my middle; the attendant then went into the water, caught hold of my hands, and jumped me into the hot water, and put my head under it several times. I was taken back by the passage into another darkish room, where two marble basins projecting from the wall were running over with hot and cold water; water was dashed over me from a cup, at first hot, afterwards tepid, and at last quite cold, and I was led back to the place where I undressed. I was then dry shampooed, and every joint in my body cracked, including my backbone, both backwards and sideways. After my dry shampooing I was covered up, laid on a cushion, given a cup of black coffee and a narghiley. I felt quite refreshed."

cold water, and well-considered means of carrying water away are indispensable, as is also the means of providing hot and dry air at any temperature and in great volume. As a good many attendants are wanted, considerable provision for them is requisite, and the bathers occupy a good deal of space, so that, altogether, a Turkish bath, which many persons attend, requires large and specially-arranged premises, and must, I fear, always remain a somewhat high-priced luxury. It affords an excellent opportunity for effective architectural treatment, and it is no doubt a very valuable sanitary agent, but the hot-air bath cannot, at any rate as at present administered, be reckoned upon as the bath for the million.

Perhaps it may save recurring to the subject, if I refer here to the vapour bath as an appliance which, combined with a needle bath or spray, is capable of being used in any ordinary bathing establishment, and of exciting something of the same sort of action on the skin as the Turkish bath. This appliance it would be possible to introduce into establishments where inexpensive baths are given with advantage. In some cases patients who are advised that the Turkish bath is not safe for them, are allowed a vapour bath, as the head is always kept out of the box in which the body is steamed. Still this more simple appliance cannot supply the popular bath that I desire to advocate.

A very considerable number of establishments, some of them opened as private speculations or by small companies, but the most part provided under the Public Baths and Washhouses Act, exist. Mr. Rosher states the number of public baths in England having a swimming-bath as part of their installation, at 200, out of which seventy are in the Metropolis alone. The avowed aim of many of these—especially of the Parliamentary ones, if one may be pardoned the phrase, is to reach the general mass of the people. In addition to the washhouses, which form no part of our present subject, we find in one of these establishments one or more swimming-baths and a series of warm baths. Let us examine the nature of each of these two provisions, beginning with the swimming-bath. Those who desire further information as to the Baths and Washhouses Act and its results, will find it in a compact and serviceable form in the comprehensive report of Mr. Ernest Turner on the subject, prepared at the time of and in connection with, the recent Paris International Exhibition.

The swimming bath is necessarily a more or less public institution. It is in its nature large and expensive to establish and maintain, but it is almost unequalled as affording to great numbers a means of healthy pleasant exercise, and as furnishing

an opportunity for the young and others to acquire the valuable art of swimming. No pains should be spared to make it attractive as well as convenient.

A swimming bath of modern construction is a large tank, usually long in proportion to its width, shallow at one end and fairly deep at the other, walled in and roofed over, with a floor all round and numerous dressing boxes. The interior should be light and airy, the water should be sufficiently warm, perfectly fresh, bright and clean, and the dressing boxes should secure some degree of privacy. As the swimming bath, if successful, will be worked pretty hard, it is necessary to have the means of rapidly and thoroughly cleansing every part in use, and of quickly emptying and refilling the bath. Gas or other lighting should be provided. In some cases provision may be made for employing the bath as a room for public meetings or a gymnasium, or in some such way during the winter time when it is not in request.

Let us look into the means of carrying out this programme.

The most important part of the whole, the swimming bath tank requires to have extreme care bestowed upon its construction lest it should leak. Portland cement concrete is so well fitted for constructing the bottom and sides, that it is not now likely that, save under exceptional circumstances, any other material will be used; formerly brickwork backed up by clay puddle was the best material available, but there was more chance of leakage, and it is said that defects were not infrequent. The pressure of the water against the bottom and sides is not formidable in amount, but the various weights are quite sufficient to cause a partial failure if the foundation gives way, so every care must be taken to ensure a uniform and solid foundation for the bottom, and similar support for the sides, as the smallest settlement will be followed by a crack, and the crack by a leak. Cement concrete is not itself water-tight, and a lining of almost pure cement is required. The actual face of the tank should be of glazed brick or tiles, though when economy is of importance, this may be dispensed with. Bands of dark brick or tile running from end to end of the bath are sometimes introduced into the bottom as a guide to swimmers in swimming races.

It is desirable to put in, at least the foundations of the external walls before beginning to dig for the bath tank, so that the excavation for the baths, when once made, shall not be again disturbed. If the tank be dug and concreted first, the subsequent disturbance of the earth in digging for the footings of the enclosing walls may be enough to cause a crack.

Any outlets and inlets required should be decided, as to both

size and position, before beginning; and the valves, sluices, &c., put in as the concreting goes on, so that there may be no excuse for disturbing the work and cutting holes in it. I know of one successful case where the side walls of the tank were first formed in trenches, and then the dumpling, or great mass of earth in the middle, was got out, and the bottom put in last of all; but there is some risk of making a bad join, and it is better to excavate the whole before beginning to concrete, and then to do the bottom first, and to bestow especial pains and not to stint material in making the join between bottom and sides.

The water at the shallow end should be rather over three feet deep, sloping to about six feet at the deep end, and it is not uncommon to have the deepest point about ten feet short of the end, so that persons diving in may plunge into the greatest depth. However this may be, every part of the bath must slope sufficiently to one point, to enable the water to be completely run off from the bottom. For cleansing purposes the corners and the join between the bottom and sides should all be rounded so as to prevent any lodgment for dirt. It is desirable to have along the shallow end a perforated pipe with water laid on, so that when the bath has been emptied the attendant may be able, when necessary, to turn on a shower of water while the tank is being cleaned out. The depth of the water should be legibly painted at the sides in several places. The edge of the paving should be rounded, and between it and the water there should be a space of about six inches, and here a stout teak rounded handrail, or an iron pipe two inches in diameter, should be securely fixed on brackets for bathers to hold. The perforated pipe already alluded to may serve this purpose where it occurs. It is desirable also to fix spittoons at regular distances round the edge of the bath, and there should be a stout step-ladder at each corner.

The dimensions of the tank must be settled with regard to the probable number of bathers and the means disposable. Every additional foot adds to cost of original construction and of maintenance, but adds also to the value of the bath to the bathers. For a public bath, less than 25 ft. width and 60 ft. length of water area is not desirable. The length may, with great advantage, be increased to 70, 80, or 90 ft., then the bath should be 30 ft. or even more wide.

At most baths there will be swimming clubs, and races will be sure to be instituted, and these festivals have to be considered. Less than 5 ft. width will not do for a racer, so that not more than five competitors could well race in a 25 ft. wide bath, and four would be more comfortable. It is rather desirable, in the interests of the races, to have the length an even number of

feet divisible by ten, then three laps make a similar number of yards, and 60, 70, or 80 yards can be swum readily in a bath 60, 70, or 80 feet long.

The water delivered into the bath, whether pumped up or from the mains of a water company, will be too cold for bathing in most states of the weather; and how to warm it is a most important point, for it is not only essential to be able to raise the temperature from the point at which it is delivered, which may probably be from 50° to 60° up to say 75°, or at least 72° Fahrenheit, but it ought to be uniformly raised through the entire mass of water in the bath. If there are cold zones and hot zones in the water, bathers will not like it, and a bath that is disliked will be of comparatively little use to its owners or the public.

In some cases hot water and steam is circulated in pipes within the bath itself, the pipes being as a rule fixed in a recess formed for them in the walls of the bath. In others a long chamber is formed outside the bath tank and filled with hot water pipes or steam pipes, and the water is admitted into this cool and returned to the bath warm. In another arrangement the water is drawn off from the bath, heated in a furnace, and returned warm. Sometimes steam is simply blown into the bath itself, an expeditious but noisy way of raising the temperature. Most of these plans are more or less liable to heat the water unequally, and in more than one of them there is apt to be introduced a pipe, or a jet, or a something which is found to get too hot for bathers to touch without injury. The plan, the results of which, so far as my experience extends, are the best, is one differing from all these. It was put up for me at the baths of the Carpenters' Company, at Stratford, by Messrs. Fraser, and I can speak strongly of the success of this apparatus as a means of warming the water uniformly and effectually, and helping to keep it fresh.

At the deep end of the bath and near the bottom an iron pipe is introduced, which is carried (outside the tank) back to the shallow end, and to which the water has free access. In the course of this pipe is introduced an iron chamber, into which a powerful jet of steam under considerable pressure is thrown; this acts upon the contained water on the principle of a Giffard's injector and hurries it on, so that it is returned into the bath travelling at some speed, and of course the water that takes its place is drawn out at the same speed. The steam mingling with the water in the chamber raises its temperature, and the result is that a stream of warmed water is always pouring in near one corner of the shallow end of the bath, while an equal quantity of cold is always leaving at the opposite end. The

temperature is by this simple means gradually and equably raised to what is required, and is easily maintained; and what is satisfactory is, that the warmth is found to be uniform all over the bath, and that as the water is always in gentle motion it keeps remarkably clear.

A method resembling that of Messrs. Fraser, but carried further, is that of Mr. C. H. Rosher. He employs either the steam-jet just described, or a pump to effect a circulation of the water in the bath tank during the heating process; but he admits the heated water at the bottom of the tank, distributing it over the floor of the bath by discs or spreaders. It is claimed that this method promotes uniformity of temperature, and rapid heating, and prevents steaming from the surface of the bath and loss of heat.

With this system of heating this engineer combines a second improvement, directed to secure economical working of a bath. The heaviest expense in working a swimming bath is usually the cost of water. It will take about 60,000 gallons of water to fill a bath 25 ft. by 80 ft. This, at 6d. per 1,000 gallons, a usual price, will cost £1 10s.; and should the bath be refilled daily, except Sundays, the expense would be £9 per week for water only, in addition to the cost of fuel used in warming the incoming water. Mr. Rosher proposes to filter and to ærate the water by appropriate machinery placed in a small chamber formed for the purpose, and so to render the same supply fit to last much longer. Filtration will, it is considered, remove the solid impurities, such for example as those which the settlement of dust on the surface of the water occasions. Aeration will oxydise, and so neutralise some organic impurity. I believe this system has been successful at Woolwich and other places, where it has been tried; and there can be no doubt that a plan which will diminish the amount of water used in a bath without rendering it less pleasant or less healthy, promises to effect a very great economy in working. Other plans for filtration have, I believe, been brought forward, but this is the most complete that has come under my notice, and the only one which includes a provision for constantly recharging the water with air.

The rest of the swimming bath may be dismissed more briefly. There should be a platform not less than four, and better, five to six feet in clear width at the sides, and ten feet at the ends, and at the deep end a stage should be erected for diving. The interior should be bright, but direct sunshine on the bathers is undesirable. A bath is best lighted by a series of ample side and end windows, but generally there is not room for that, and a great skylight has to do duty, which it does very well.

There should be ample ventilation under the control of the attendant and not of the bathers. Ventilation in a swimming bath is a little difficult to maintain without discomfort to the bathers, especially when the atmosphere is much colder than the air in the bath. A few steam pipes or hot water pipes to warm the dressing boxes are of essential service, both to aid in this and to keep the place comfortable in cold weather, though it must not be forgotten that the large mass of tepid water radiates heat into the chamber that contains it.

There should be near the entrance a small shallow bath supplied with hot and cold water and a tepid spray; often called a soap hole; for bathers who come in from dirty work and desire to wash themselves clean before plunging into the swimming bath.

A small laundry for towels and bathing dresses should adjoin, and can be worked by the same boiler as supplies steam for heating water for the swimming bath and the warm baths. It will include some tanks, a boiler, a centrifugal wringer, and a hot closet; and my experience, as far as it goes, is that the hot closet will be better worked, and with more certainty, if it has an independent furnace, and is heated by hot air, than if the heat be obtained from a steam coil.

Turning now to the other part of an establishment of public baths, we find a provision of warm baths, similar to that familiar appliance for bathing now rarely absent from any good private house, the ordinary warm or slipper bath. This name was, I believe, given at a time when it was often customary to cover over the small end of the bath, so as to produce something not at all dissimilar to a brobdignag slipper. We will use the name, as it is distinctive, though not now quite descriptive. It is at least better than plunge bath.

The slipper bath varies between 5 ft. and 5 ft. 9 in. in length, and is always wider at the end intended for the shoulders. An average bath is about 2 ft. wide at the top where widest, and slopes down every way; and when filled sufficiently for comfort will generally be found to contain not less then twenty-five gallons of water, and often much more, reaching sometimes to fifty gallons. Usually about one half of this quantity will be hot water, though this depends on the temperature at which the hot water is delivered.

A great deal of ingenuity has been expended upon improving and cheapening slipper baths. The best probably are of earthenware, enamelled; copper enamelled is very much used, as are iron and zinc. Marble used to be used. At the brine baths at Droitwich baths of teak are largely employed, and they are there preferred to those of any other material, partly on account of their retaining the heat, and partly because they do not feel at

all slippery. I am told there is no difficulty in keeping them perfectly clean.

Where it can be afforded every such bath should have an independent dressing-room, and it is often of advantage for the bath-room to have two dressing-rooms, one on each side. Suitable dimensions are for the bath-room about 10 ft. by 7 ft. 6 in., and for the dressing-rooms 10 ft. by 6 ft. 6 in. In a room of this size the bath should stand clear of walls at either side. In cool or cold weather these rooms should be heated, and if the dressing-room can have a little fireplace and a small open fire, it adds to the sense of comfort. A hot closet for keeping towels, &c., hot and dry, is a desirable adjunct to any complete set of slipper baths. Hot and cold water is, of course, laid on to each bath, and the attendant's duty is to fill the bath and bring it to a proper temperature.

When baths for the many are constructed the above programme is too luxurious. One compartment must then do duty as bath-room and dressing-room. The minimum size for such a room is 6 ft. by 5 ft. 6 in., but a little more space is very desirable. The bath fittings are usually so arranged as to give the control of the hot and cold supply to the attendant, who will add more of either from the outside if called. The floor of the bath room should be covered, or partly covered with open wood lattice work, to keep the feet of the bathers dry. The enclosure of the bath-rooms may be formed of sawn slate or even of galvanised and corrugated iron in wooden framework; and it is important that the cocks and valves should be strong and well made and asbestos packed, as there will be much wear and tear.

In some cases, baths of a shape different from the received slipper bath are used for the warm bath. At Buxton, for example, a warm bath is a kind of tank lined with marble, and with steps leading into it at one side and a kind of bench at the other. The patient takes the bath in a sitting position and not reclining, and when it is wished, as is sometimes the case, that the lower limbs only should be bathed, he sits on one of the steps. If he sits on the bench he is immersed nearly to the chin. In the same baths, the mineral water which comes up at a temperature of 82° is used in baths which are also small tanks or pits, but large enough for the bather to move about in freely —say (speaking from memory) 5 ft. by 8 or 9 ft.

As Buxton has been mentioned, perhaps it may be appropriate here to say that I have felt that it would extend the scope of this paper too far, and carry me away from what is its special aim, were I to take up the elaborate and skilfully contrived appliances which are to be met with at such places as Bath

or Buxton, and at the principal continental resorts, such for example as Aix-les-Bains, for administering thermal and other waters as curative agents. Still less is it proposed to touch upon hydropathy or the appliances employed in water-cure establishments. To-day I am endeavouring to direct attention to appliances fit for the use of the people, rather than to the more costly and special ones designed for the treatment of special diseases.

It must be admitted that while the operation of the Baths and Washhouses Act has brought a means of bathing within the reach of large numbers of people, it has not gone far enough. I believe it has been the experience of the Managers of many of these establishments, that they are not frequented to such an extent as to make them self supporting; and it needs no long consideration to see that the prices charged, though very moderate even if they reach the maxima fixed by the Act, do not place the bath within the reach of every class of working people; while the mere fact that these establishments must be on a considerable scale, and therefore cannot be very close together, removes them from the easy access of some of those who would use them if they could.

Can we bring the bath nearer to the doors of the people, and can we give them a cheaper bath than anything accessible at present?

As to bringing baths nearer to the homes of the people, we shall, I am informed, have particulars of what has been done in Brighton itself.

In London and other crowded towns and cities I have no doubt that simple, cheap, and accessible bathing establishments, formed in crowded neighbourhoods, set up as a rule in existing buildings, and adapted to the wants and the purse of the crowd, would be popular and largely used; and my impression is that they could be made to pay their expenses, and possibly to yield a profit to those who established them. If so, few better openings for practical benevolence seem to exist than the multiplication of appliances of this sort under prudent and careful direction, and I wish the subject may attract the attention of philanthropists.

Returning to the question of cheapening baths, let me remind the Congress that a practical attempt to bring a thorough bath within the reach of the million—that is to say to give a good warm bath for a penny—was described by Mr. C. C. Walker, of Lilleshall, at the Worcester Congress of this Institute. I have had an opportunity of visiting Mr. Walker's baths this summer, and though I shall not attempt to reproduce his technical description, which is already in print in your transactions, I will,

with your permission, briefly describe what I saw. In a modest, but perfectly neat, clean, and quiet brick building put up for the purpose, I found a range of small bath-rooms, each 8 ft. by 4 ft., all opening out of a paved corridor. Entering one of these the would-be bather, who is probably out of the adjoining foundry, and black with the dirty work he carries on there; or perhaps a still more grimy collier, from one of the neighbouring coal-pits, finds a capacious inviting-looking circular pan near the ground at the back of his compartment, and two taps, one of cold and one of hot water, and a stool, soap, flannel, and brushes, all ready for his use. He is directed, after undressing, to half fill this pan, with the warm and cold water laid on, to the warmth that suits him, and then to give himself a regular good wash in it. When he has soaped, and splashed, and rubbed to his heart's content, he can stand up in the pan, where close above him is a large copper rose. Pulling a chain, marked warm, a shower of light warm spray gently descends, and streams over his shoulders and chest, or head if he likes for it is mild and harmless. Another pull enables him to mix cold with the warm, and it is recommended to the bather, after thus cooling himself down, to finish off with a cold spray. This arrangement, simple, sensible, and pleasant, has been found immensely popular among the foundry men, and they have admission at a rate that is almost nominal. The outside public are admitted to this bath, which may be appropriately termed the Walker bath, and described as a "soap and spray bath," for a penny, this entitles the bather to a towel, but a piece of soap is a halfpenny extra. Mr. Walker believes that this penny fully meets the expense of his bath, but then there are exceptional circumstances in his favour, both as to initial cost and working cost. However that may be, there is no doubt that a soap and spray bath of the Walker type can be given more cheaply that a slipper bath, especially if it can be combined with some other establishment as, for example, a swimming bath. The points in its favour are that it affords an opportunity for a thorough good cleansing wash; that it consumes much less water than a slipper bath (the usual quantity used being found to be about eight gallons of warm water and a smaller amount of cold); and that considerably more baths can be given in a day. A slipper bath is usually detained half-an-hour by each bather, a Walker bath only twenty minutes; so that in a day of, say ten hours, thirty of the baths could be given in each bath-room as against twenty of the former.

Persons who manage warm baths, have constantly on the women's days, applications from women who bring two or

perhaps even three young children, and desire to give them a good wash, usually stipulating that they shall have only to pay for one bath though they occupy a bath-room a long time. For this kind of family bathing, Mr. Walker's bath seems particularly well adapted.

It appears to be not too much to hope that these appliances may be introduced into the humbler class of private houses, where a slipper bath would be rather too elaborate and expensive. A bath closet eight feet by four, floored and lined with Portland cement could be easily constructed and takes very little room, the pan, the spray, and the cistern to supply the warm water are simple, and a simple circulation of hot water either from the kitchen range or from a small tubular boiler and stove for the purpose, is not very costly, and the whole would afford the opportunity of a healthy and a pleasant bath in many a house of moderate pretentions, which will be occupied by artizans or persons a little above the artizan class.

This perhaps is looking ahead; at the present moment it may interest the Congress to know that an experimental trial is about to be made of a few of Mr. Walker's baths in London. The Carpenters' Company, which has a large estate at Stratford, in the East of London, upon which many hundreds of working people reside, has erected, mainly for their advantage, swimming and warm baths, which have proved a most encouraging success, as they have been through all the temperate and warm part of the year largely frequented. To these a few baths, as closely copied in every detail from those just described as possible, are now being added under my superintendence. The apparatus now being put up for us I have every reason to hope will work as successfully as in Mr. Walker's own establishment. We hope to be able to offer these baths to the public at a very low rate; and though as a novelty they may at first be distrusted, my belief is that they can hardly fail to become liked, for I know of nothing so well adapted to the requirements of working men.

Mr. Walker's plan is not, however, the only one that must be brought under your notice, nor do I claim for it that it is the best cheap bath for all classes and under all circumstances.

In the German barracks a spray bath is adopted which is the invention of Mr. David Grove, an engineer, holding a government appointment in Germany. This is minutely described in a pamphlet, for a copy of which I am indebted to Mr. Jennings. The essential points in this invention are that a large cistern is fixed at a level considerably above the floor of the bath-room, and simple means are provided for warming the water in this cistern and maintaining it at a temperature of 95°. A series

of open bathing compartments, each 3 ft. 3 in. wide and 5 ft. 8 in. high, occupies the middle of a large room. The men undress at the sides of the room, and enter the compartments in detachments. In each compartment is a spray fed from the warm-water cistern, and all are turned on at one time and shut off simultaneously. The sprays are oblong, perforated with fine holes and fixed slanting, at such a height and at such a slope that the jet of spray falls on the neck or shoulders of the man standing in the compartment, and not direct on his head unless he bends down for the purpose. The spray is continued for 3 to 3½ minutes; and it is stated that with 18 bathing cells 300 soldiers can be bathed in an hour, and that the quantity of water consumed for each man is 15 to 20 quarts. The men are required to take soap with them and use it. It is claimed that this arrangement is well adapted for public institutions, schools, &c., as well as for army use; and I understand that it has been more or less employed in such places in Germany.

Another spray-bath has been of late introduced, and has been found successful. It has recently been stated that the late Sir Edwin Chadwick advocated something of the sort, and that Messrs. Doulton constructed an apparatus; but the spray bath that I now refer to seems to be due to the ingenuity and skill of Mr. E. A. Reynolds.

As I have seen it, the bathing apparatus is contained in a kind of cabinet of sawn slate about 2 feet 6 inches square and 7 feet high, with glass doors. The bather, on entering this and pulling the proper string, finds a number of fine jets of warm water directed on him from the sides, the floor, and from the ceiling. He can control the temperature of the jets; and when they have played on him for sufficient time, he shuts off the spray and withdraws. It will be seen that here, as in the German plan, there is no *tub*, and that no soaping will be easily possible, so that probably the bath, which is said to be extremely enjoyable, will be popular with people whose pursuits do not cover them with dirt and dust. One, if not more, of these spray-baths has been fixed by Messrs. Marshall and Snelgrove in the house where their young men reside, and that is exactly the sort of situation for which it will be best adapted. The water consumed for one bath is said to be, as a rule, three to four gallons, and the bather does not remain long in the compartment.

It will be manifest that the spray bath pure and simple, is pretty sure to be more economical of time and water than the soap and spray bath, and there are some situations where this economy is of importance and will turn the scale in its favour. But for operatives who want a thorough wash, and to have that wash in quiet and comfort, the Walker soap and spray bath seems by far the best hitherto introduced, and it will I trust meet a real want.

My intention is not, however, to advocate any one plan, still less to assert that the limit of improvement has been yet reached, but to point out that the means of putting a good bath within the reach of that large section of our community, who can only afford to pay the lowest price, are actually at our disposal. There are none of our fellow subjects who more need a bath, or will be so much benefited by being able to obtain one. If we can largely extend to them and others the means of cleanlines, we shall promote health, decency, comfort, and self-respect, in short, sanitation in its most comprehensive sense.

It is time to draw these observations to a close. A well known proverb says, "Cleanliness is next to Godliness," and I hope my hearers will not think that this proverb has so sunk into my mind that I have been betrayed into a sermon instead of a scientific discourse. Pardon me if this has been the case, but agree with me if, in conclusion, I repeat that cleanliness *is* at least akin to godliness; and, permit me in closing to quote a few apposite words from a paper of racy personal recollections of the Sage of Chelsea, from the pen of his friend Emerson, who says that: "In the decay and downfall of all religions Carlyle thinks that the only religious act which a man now-a-days can securely perform is to wash himself well."

Sir Thomas Crawford (London), in proposing a vote of thanks to Professor Smith for his paper, observed that the subject was one which was directly connected with the health and welfare of the people. With regard to public baths, he called the attention of the authorities of Brighton to what appeared to be a want in their town. Brighton, he allowed, was well provided with public baths, and its sanitary committee was anxious to make them conveniently accessible to the public; but the expense attending one class of baths, at least, was prohibitive to certain of its visitors and inhabitants, and he thought that the complaint which had been made to him in this respect in a letter from a lady was deserving of the sympathy of the public. This lady was an invalid, writing from her bed, and she wrote that, living as she did—on a small pension—she could not afford the expense of the sea-baths which her health demanded; nor was she the only person feeling the want of cheap warm and cold sea-water bathing. She suggested that some of the apartments on the sea-front might be used for this needed purpose. Whether this

could be done or not, he sincerely hoped that Brighton would keep before them the example of the Romans, and that before many years elapsed the town would be celebrated as much for the cheapness as for the excellence of its baths—the public being able to get either warm, tepid, or cold sea-water bathing as they might require. Indeed, sea-bathing he held should be one of the main attractions of Brighton.

Alderman Dr. J. Ewart (Brighton), in seconding the vote of thanks, said that he felt that the paper was one which deserved the special attention of the Brighton authorities. Not that Brighton had been backward in its private and public bathing arrangements, for they had both swimming and slipper baths for the well-to-do portion of the community, whilst for the public at large they had two large bathing institutions at very cheap rates. He was happy to say that the older of these two bathing places was a very handsomely-paying concern, whilst the second, opened two years ago, was so rapidly increasing in demand that there could be no doubt that that also would shortly prove highly remunerative. With reference to the suggestion made by the President of the Congress, he might say from recollection that the subject of providing cheap sea-baths for the people had more than once been under the consideration of the Baths' Committee of the Town Council, and he felt certain that this evident demand would be adequately met. Then there was another suggestion made by Professor Smith with regard to the provision of swimming-baths for Brighton; that subject had entered largely into a paper read already by himself to the Congress. He believed thoroughly in the need of such an establishment, for it was necessary in all towns that the people should be taught to swim, both for their own safety and also on sanitary grounds; indeed, he relied more on this form of bathing than on the elaborate but rather effeminate institutions which existed in ancient Rome.

Mr. Charles Rosher (London), in reply to Professor Roger Smith's demand for greatly increased facilities for public bathing, suggested that the School Boards should take the matter up, and build baths in connection with schools, making swimming a compulsory part of the children's physical training, and that baths so established should be available for general public use between stated hours, on payment of a small fee, which would assist in making them self-supporting.

The vote of thanks was carried by acclamation, and Professor Roger Smith, in reply, remarked that he should be glad if anything he had said served as a suggestion for popularising baths either in Brighton or elsewhere.

On "The Brighton Waterworks," by Alderman W. H. Hallett, F.L.S., J.P., D.L.

ABSTRACT.

The Water supply of Brighton is obtained from a depth of 150 feet below the surface; the water is pumped into elevated reservoirs, varying in heights, for the purposes of convenient distribution—so constructed as to be closed against the action of light and of atmospheric influences, and containing large bulks of 1,000,000 gallons and upwards, the water in them constantly changing.

On the Southdowns, which environ Brighton for an area of sixty or seventy square miles, no lakes or rivulets are seen. The sub-soil is in general that of the upper chalk formation with flints. The two rivers, the Adur, five miles west, and the Ouse, eight miles east, which flow through the hills, serve as the drainage of the Weald, not of the Downs.

Explorers in the chalk find fissures through which pass rivulets and rills seawards, and below low water mark on the seacoast fresh-water springs find their way out.

Formerly wells were sunk in the chalk formation with an uncertainty as to the result, very like that which is still experienced by those who dig in the Sand Rock.

In 1830 an effort was made by a Company to secure a systematic supply to the town of Brighton, and their first well was sunk in the Lewes Road. The water was raised by steam power to a reservoir 220 feet high. The supply being easily pumped out, to increase it tunnels were driven in the form of a cross, also to serve as a storage to pump against. A boring was also tried to a greater depth, but without beneficial result.

In 1852, consequent on great complaints of the inadequate water supply, a new Company replaced the first, with powers to carry out extensive works, and also undertaking to give a "constant" service supply.

This duty of giving a "constant" supply the Company afterwards desired to be relieved of, but were unsuccessful. They found that although only 7,000 services were connected with their system (hardly half of the then existing houses) that their supply was quite inadequate. They sunk a well at Preston, on the east side of Miller's Hill, hoping thereby to catch water coming from the upper part of the valley of Patcham, but

without good result. The Patcham water was found to draw to the east, and the tunnels at Lewes Road being extended to their western limit, intercepted some of this supply of the Patcham springs.

The Directors then called in Mr. James Easton, who had successfully secured water for the supply of Ramsgate, built on the chalk formation of the Isle of Thanet.

Mr. James Easton's method of cutting across the fissures is that which is acted on in all the water stations of the Corporation.

He had ascertained and proved that where the stratification of the chalk has not been disturbed by upheavals or depressions, the fissures, which are the water conduits, are found to be at right angle (or thereabouts) with the coast line.

Each fissure contains a small rivulet, beginning at the supersaturation of the chalk, and flowing on and collecting more water as it proceeds.

The sides of the fissures are coloured by infiltrations of particles of the upper clays.

The fissures are seldom more than a few inches wide, generally not one inch. Hence there is considerable resistance to the passage of the water. At a distance from the outlet, the water stands higher and higher in the wells as the distance increases, as was shewn by Mr. Edward Easton, C.E. (with diagrams) in his paper on these waterworks read at the Brighton Health Congress in 1881.*

In an earlier paper, read in August, 1872, at the meeting of the British Association in Brighton, Mr. Easton stated that the maximum of water in the chalk is generally in the month of March, and the minimum in the months of October, November, and December. From diagrams of curves then shown by him of the varying depths in the wells, the supply appeared to reach them in three and a half to four months after rainfall. He concluded that the chalk acts as a storage-reservoir in retaining the usually heavy rainfalls of the months of October, November, December, and January, during which time evaporation is least in operation.

Up to 1865 the whole supply of the Company was drawn from the Lewes Road Works, when the Directors began to prepare for a new and independent supply to meet a growing and an expected increasing demand. They then commenced at Goldstone Bottom, on the west side of Brighton.

In his paper (August, 1872), Mr. Easton stated that there

* Transactions of the Brighton Health Congress, 1881, page 48.

were two distinct sources of supply, each sufficient to give a maximum supply. That there were three sets of engines, each equal to the delivery in twenty-four hours of the then maximum demand, and that there was storage capacity in the reservoirs equal to two days' supply. There were then 18,000 services connected, of which 5,000 were on the "Constant" service. The tunnels in Lewes Road were 2,400 feet in length, and those at Goldstone were 1,300 feet in length. The town was divided into four zones, served from "Low," "Middle," "High," and "Higher" Reservoirs.

This answers as a stock-taking account of what the Corporation obtained for their purchase on acquiring the control, 1st July, 1872.

In 1871 the Corporation gave notice of their intention to apply to Parliament for a Bill to enable them to purchase the Waterworks compulsorily. When the Bill was deposited the Company's solicitor represented that the Directors would fight the "compulsory" clause, but would concur in a clause for purchasing by agreement.

The terms arrived at were quite as moderate as would then have been imposed by a Parliamentary Committee, and were satisfactory to all concerned in the sale.

The Waterworks Committee was appointed in July, 1872, and chose Alderman Ireland, Chairman. In June, 1874, an outlay of £30,500 was voted at once, involving a new charge on income of £1,600 a year. This provided a duplicate engine at Goldstone, costing £16,000, a new middle reservoir for the west, new mains, and also a liberal sum for driving tunnels. The droughts of 1873 and 1874 made this feasible, and by November 1st, 1874, great extensions had been made. On that day an exceptionally large fissure was opened at the foot of the entrance well, driving the men up hastily, and no further work was admissible for several years.

With the best will to do everything necessary or desirable the Corporation would not have succeeded as they have done in eighteen years, but for good and energetic advisers. From Mr. Edward Easton, C.E. (son of Mr. James Easton, already named) they have had such plans submitted from time to time as have served to keep every part of the great undertaking well up to the mark. By their local engineer, Mr. John Baker, works of very arduous character have been carefully executed, and he has now the entire responsibility for carrying out the new pumping-station at Patcham.

In August, 1872, the Chairman, Alderman Ireland, informed his committee that he had authorised discontinuance of pumping at Lewes Road for a few days, so that all the town supply

was worked by the ONE engine at Goldstone. The object was to allow of a visit to the tunnels by a party of the British Association, then meeting in Brighton. Professor Fawcett, M.P., was amongst those who made the descent. Now, in 1890, to enable your members to inspect the tunnels (in the same month of August), TWO engines have worked night and day for four or five weeks, and an intermission of two or three hours pumping would leave the water over the banks and impassable, so that no visit could be made.

The method hitherto pursued has been to sink the tunnels as nearly as can be to sea-level. It has been long known, however, that the chalk-fissures go much lower, as some have been plumbed 150 feet without finding bottom. Mr. Baker, after very extensive workings, is of opinion that, if an opportunity offered, there might be intercepted below that level, great supplies which are now escaping seaward. That subterranean conduits are at work at lower depths, and most probably finding an outlet under the sea, seems to be shown by the Warren School well, which was dug to a depth of 1,285 feet before meeting with water—or 700 feet below sea-level. When water was found it rose to about 100 feet above sea-level; pumping for seven hours at the rate of 8,000 gallons per hour, lowered it 13 feet. Apparently, the source of supply was not strong. The water was not from the chalk, but from the Lower Green Sand. The nearest Green Sand formation is a narrow belt on the north side of the Southdowns. If that was not the source of the Warren well, the next possible source would be the Reigate Sands.

The break-down of machinery, through which the Corporation obtained control, naturally kept that subject prominent in the minds of the Waterworks Committee, so that they were sensitive in any delay in repairs. Not long after they had control a delay occurred, and it was at once resolved to have as much as possible done locally. The Committee were fortunate from the first in having one of its members, Mr. John Chester Craven, C.E. (for years Locomotive Superintendent of the London, Brighton, and South Coast Railway Company), eminently able to give engineering counsel, and in 1882 he strongly advocated Mr. Baker being allowed, as he himself desired, to have works of his own to do repairs. The mechanical appliances have been gradually added to, and the Committee have every reason to be satisfied with the results of their expenditure for plant, now reaching upwards of £2,000. With it Mr. Baker turns out every subsidiary part used—pistons, buckets, &c., &c. He informs me that, with the plant he now has, he could furnish a 50-H.P. or even a 100-H.P. engine if

ordered. Duplicates are always on hand ready to promptly replace any part.

I have referred to Mr. Easton's stock-taking in 1872, and to the £30,500 passed by the Council in 1874 to carry out all that the Directors of the Company had had under consideration. The Corporation paid £350,000 for what they bought, and their capital debt is now £500,000. One hundred and fifty thousand added in eighteen years (inclusive of the £30,500 just named), and what is there to show for the new outlay? The first step was to devote grounds at Lewes Road Station, and build greenhouses at a cost of £1,000 for the head gardener, who supplies therefrom all the plants required by the Recreation-ground Committee. High, middle, and low reservoirs now exist on each side of the town, intended to balance each other, so that water pumped at one side can transfer to the other, and great mains have been re-arranged and relaid for that purpose. The fire-mains have been materially improved in their force everywhere. The constant-service main is everywhere. The Corporation have striven energetically to induce its use, and at the end of 1889 there were 18,812 constant, against 6,893 which are still intermittent, or 73 per cent. of "constant" service connections. In 1872 there were less than 28 per cent. connected. It is hoped that the remainder will come in more rapidly under the pressure of good example, but the cost of changing the pipes in a house to be adequate for the greater pressure from the public reservoirs deters many. The capital has increased 33 per cent., and the revenue from £24,000 to £42,000, or 75 per cent. There is a gradually-increasing margin of profit notwithstanding so much more is supplied by the constant service, and although the Corporation supply water for street flushings both in Brighton and Hove (which may be counted in millions of gallons in the year) without any charge whatever; while the Company never supplied water for public uses without charges.

There must also be included in the £150,000, the purchase of the West Brighton Waterworks (£15,000), and the preparations for a station at Patcham, £10,000.

Nothing can better demonstrate the superiority of the present mode of seeking for water in the chalk than comparison with what the Directors of the Company did before the system was known. They actually dug in the Patcham Valley for water and relinquished their attempt, while the Corporation from 1883, and without fear of any failure, deliberately go to the same Patcham Valley for their third supply. To the works at Goldstone this better state of knowledge is owing, and to Mr. Baker's keen appreciation of the state of water

affairs near Patcham tunnel may be attributed Mr. Easton's report in favour of a new station there.

A visit on the 6th of December, 1884 (after the Healtheries Exhibition), of engineers representing great London water companies was made to the Goldstone tunnels. Sir Francis Bolton and his colleagues of the East London Company left them intending to adopt a similar system—2,000 feet have been tunnelled already.

Mr. BALDWIN LATHAM (London) reminded the Section that for the last fifteen years he had been carrying on over the chalk districts of England observations on underground water. He asked if any survey had ever been made of the area which contributed the water supply of Brighton? In many towns the water-works were located with very small consideration to their surroundings, and in many instances water-works had been constructed which had proved an absolute failure. At Caterham well after well had been sunk without any success whatever in getting an adequate supply of water. They had been so sunk on high ground that it was like endeavouring to collect water at the top of a spire. So unsuccessful had their previous efforts proved that the Caterham Water Company had had to buy up another water-works, and now from a lower point in the valley they were sending back water to Caterham to be softened and distributed. It was important both from a sanitary point of view and from the view that the works themselves should be adequate, that before undertaking the construction of water-works local authorities should have an accurate knowledge of what quantity of water they were likely to get from the site selected. He thought that the question of water supply was much more important from a public health point of view than even drainage works. The fluctuation of water was shown in the death rate of children, and the mortality of a district might be easily and correctly estimated by taking the deaths of children under five years of age, and comparing them with the exact fluctuation of underground water. The lower the water the higher the death-rate would prove. There had not fortunately been any very low water since the periods of 1854, 1864, and 1874 (that of 1864 was the lowest), and he thought if they ever got into such a low state again it would prove a true test of the value of their several water-works. He was sure the Corporation of Brighton were to be extremely commended for having seized an opportunity to get absolute control of the water supply. It was very unfortunate for any town to have two services (intermittent and constant), and he would have all intermittent supplies abolished. It would prove to their advantage to do so, and it would be found to be true economy. Indeed, there was nothing to gain but everything to lose by continuing intermittent supplies. More water was used in intermittent than in constant

services, and it would be a great advance for the constant service to become general in Brighton. There was no decrease in a volume of chalk by reason of the solvent action of water; in fact, this action was extremely slow, and it was only to the depth of the first fifty feet that any change took place. One effect of rain was to saturate only the upper layers of chalk, and that was why in chalk water they always found a uniform quality. Moreover, the quantity of water absorbed by chalk was comparatively small—of rain about one-third only going into the chalk. Chalk water had a low temperature, but when it was distributed this was different. The temperature supplied to the town was the temperature of the ground where the mains were laid, and if they took the temperature of water from any drinking fountain in Brighton, they would find it very different from that found in connection with water in a well, whilst it would be very much the same as that taken from a drinking fountain in London. To the increase in the temperature of drinking water he attributed summer diarrhœa, and if they wished to keep this temperature down they must lay their mains at a considerable depth. It was advantageous for Brighton to have its reservoirs close to the town, but if the water had to pass for a mile or a mile and a half through water pipes the temperature was sure to get high. He was much interested himself in the question of Brighton water supply, and he felt very indebted to Alderman Hallett's valuable paper, for every one of the records it contained added greatly to the value of engineering literature.

Mr. R. F. GRANTHAM (London) directed his remarks to the additional stores of water found below the level of the sea, and gave his experience of wells sunk by his father and himself at Littlehampton to corroborate Mr. Baker's statement that large quantities of water were to be found below the sea-level. It is becoming the custom now, he added, not to soften chalk water; the new waterworks at Croydon supplied their water from a chalk well, but did not soften it at all.

Alderman W. H. HALLETT (Brighton), in reply, explained that his remarks about chalk becoming more porous were taken from a report to the Royal Commission, whose members, it might be admitted, held views which were not accepted now. To his knowledge no complete survey of the area which contributed to Brighton water supply had been made. He would mention in a general way that it extended as far as the Dyke, and that they were overburdened with water, for the supply was double what was consumed; under these circumstances, there was no likelihood of Brighton having yet awhile to go below the sea-level for its water.

On "Water Works Regulations," by REGINALD E. MIDDLETON, M.Inst.C.E.

THE subject on which I have been asked to write is that of Water Works Regulations with regard to their bearing on sanitation.

I have obtained copies of regulations from some twenty-two corporations and companies in about equal proportions.

Most of the corporations and companies provide their regulations in the handy form of small pamphlets, which bear throughout a general family likeness; and it is only in a very few cases when there is any marked departure from the general form, and this departure is for the most part in the direction of omissions.

I quote the Regulations of the Liverpool Corporation Water Works *in extenso*, as being, perhaps, as complete and simple as any others.

1.—Persons requiring a supply of water must fill up, sign, and deliver a form of application, to be obtained at the Water Engineer's Office, and pay to the Treasurer a sum equal to one quarter's water rent, also a deposit (the amount of which will be stated when the application is presented), on account of any piping or fittings which may have to be furnished or laid for the applicants by the Water Committee.

2.—Such persons must, at their own cost, provide, lay down, and maintain all service pipes and fittings which may be required within their premises, and one foot of pipe beyond the boundary thereof; and in the case of all premises situated outside of the Borough, or of supplies for other than domestic purposes within the borough, they must also pay the cost of providing, laying, and maintaining the piping and fittings necessary to form a connection with the main, which work will be done on their behalf by the servants of the Corporation.

3.—The Corporation will publish on their Water Rent Papers, on the Waste Water Notices, and in such other manner as they may from time to time consider necessary, the names and addresses of such plumbers as they may approve of, who undertake to execute work in accordance with the following Regulations; and such plumbers will become responsible to the Corporation for the proper execution of all work done by them, and before they are placed on the list will sign an agreement accordingly. If they fail to comply with the requirements of the Corporation, their names will be struck off the list.

4.—All fittings used in connection with a supply of water must be tested and stamped by the duly authorised officer before being fixed, and the following Fees will be charged:

Bib and Stop Taps.....2d. each.
Ball Taps.....3d. „
Closet Cisterns with Ball Taps .....6d. „

5.—A set of standard fittings such as have been hitherto approved is exhibited in the Stamping Office; but the Engineer will give due consideration to the claims of any other fitting which may be presented for approval, and which, if considered satisfactory by the Committee, will be stamped, the sample purchased and placed among and become one of the standard fittings.

Before any fitting is withdrawn from among the approved samples, six months' notice will be given to the Master Plumbers' Association.

6.—Every service pipe hereafter laid or fixed below ground shall be of lead; and every joint on every lead pipe, whether below the ground or not, shall be of the kind called a plumbing or wiped joint.

7.—All service pipes laid underground must be at least 2 feet 6 inches below the surface, and must be brought out through the boundary of the premises 2 feet 6 inches below the surface of the street or roadway.

8.—Lead service pipes, for supplying water for domestic purposes, must be of the diameters stated below:—

For 1 house, not exceeding £20 per annum rateable value, ¾ inch diameter.
For 1 house, above £20 but not exceed £70, or for 6 houses, not exceeding £13 each rateable value, 1 inch diameter.
For 1 house, above £70, or 14 houses not exceeding £13 each rateable value, 1¼ inch diameter.

9.—No house or block of offices in the same building belonging to the same person, shall have connection with the pipes or other fittings of any other premises. Where two or more houses of a rateable value exceeding £13 per annum each are supplied from one cistern, a leading pipe from the cistern must be laid in the back passage, and separate branches taken therefrom into each house; and in all cases of blocks of houses, whether under or exceeding £13, supplied from one cistern, a by-pass pipe, with stop-cocks, must be placed in such a manner as to lead the water direct from the mains to the houses during periods of constant service.

10.—Lead pipes shall be of not less than the following weights per lineal yard:—

PIPES IN THE UPPER DISTRICT AND IN THE LOWER DISTRICT IF SUPPLIED FROM A CISTERN.

¾-in. dia.....	4½ lbs. per yard.	¾-in. dia.....	8 lbs. per yard.
1 „	5 „ „	1 „	11 „ „
		1¼-in. dia.....	13 lbs. per yard.

PIPES IN THE LOWER DISTRICT UNDER PRESSURE FROM THE MAIN.

¾-in. dia.....	4½ lbs. per yard.	¾-in. dia.....	11 lbs. per yard.
1 „	7 „ „	1 „	15 „ „
		1¼-in. dia.....	18 lbs. per yard.

Any lead pipe of which the end is open so that it cannot remain charged with water, may, however, be of the weight given in the following scale:—

½-in. internal dia.....	3 lbs. per yard.	1-in. internal dia.....	7 lbs. per yard.
¾ „ „	5 „ „	1¼ „ „	9 „ „

11.—Pipes of any other metal than lead shall only be fixed after samples thereof have been submitted to and approved by the Water Committee.

12.—No pipe shall be laid through, in, or into any sough, drain, ash-pit, manure-hole, or other place from which in the event of decay or injury to such pipe, the water might be liable to become fouled or to escape without observation, or without occasioning the necessity for immediate repair.

In any case in which any such sough, drain, ash-pit, manure-hole, or other place as aforesaid, shall be in the unavoidable course of the pipe, such pipe shall be passed through an exterior cast-iron pipe, or box of sufficient length and strength to afford due protection to the water pipe, and to bring any leakage or waste within the means of easy detection.

13.—No pipe shall be brought above the level of the ground outside any building, except for the supply of an outside tap in a yard, in which case the pipe shall be properly protected from frost by brickwork, or otherwise, and encased in felt, or other non-conducting material, to the satisfaction of the Engineer.

14.—Every separate service-pipe must be provided with a stopcock and box which will be fixed outside the private premises by, and in cases of domestic supplies within the Borough at the expense of the Corporation.

15.—A tap shall be placed in each house, on the leading pipe from the main, in order that water may be drawn for drinking and culinary purposes without passing through the cistern.

16.—Storage cisterns must be provided for all domestic supplies. Where there is a bath or hot water apparatus, the cistern must hold not less than 50 gallons for each house. In other cases, not less than 25 gallons for each house.

17.—Cisterns for the storage of water (not including water closet and urinal regulating cisterns) shall, if of wood, be lined with lead of not less than 5lbs. to the square foot. The iron, wood, or slate work shall be strong and well put together, and each cistern shall be provided with a ball tap which must be securely fixed to the side thereof, and it must be in such a position as not to become submerged when the cistern is full, and the level of the water at such time shall be three inches below the overflow.

18.—Domestic boilers, water-closets or urinals must in all cases be supplied from cisterns. All cisterns for the supply of water-closets or urinals shall either be on the alternating valve principle, and so constructed as to be capable of delivering two gallons at each flush, which must be discharged within 15 seconds, or otherwise so arranged as to produce the same result in an equally efficacious manner; but no valve except the ball cock shall at any time have a greater pressure upon it than that due to the head of water in the cistern.

19.—Overflow pipes of cisterns or other receptacles for storing water shall be not less than ¾-inch internal diameter, and wherever the level of the cisterns will admit of it, they will be brought to conspicuous points above the ground on the outside of the building containing the cisterns, in such a manner as to act as warning pipes, but in no case shall they discharge over the ashpit. Where a cistern is too low to admit of this, the overflow pipe shall be fixed in such a position as shall be determined, in writing, by the Engineer.

20.—No pipe for the conveyance of, or in connection with, water supplied by the Corporation, shall communicate with any cistern or other receptacle used, or intended to be used, for rain water.

21.—No cistern for a domestic supply of water shall be built or placed under the surface of the ground.

22.—Every cistern shall be in an accessible position, and made capable of easy inspection.

23.—Where a cistern is fixed in an exposed position it must be bricked around, or otherwise encased and covered, so as to prevent, as far as practicable, the action of frost upon the water.

24.—The pans or basins of all water-closets, not of the trough kind, must be of a semi-circular shape, or of such other form as can be most efficiently flushed; the down pipe from the cistern to the basin of the closet must be of not less than 1¼ inches in diameter, except in connection with pan closets, where the head of water exceeds 8 feet, when the down pipe may be of 1 inch diameter. In the case of pan closets, the metal pan shall be capable of bearing a weight of 7 lbs.

25.—The detail arrangements of all trough closets shall be submitted to, and approved of, by the Engineer before such closets are fixed.

26.—Every bath must be provided with a well-fitted and perfectly water-tight ground outlet plug, with chain complete, or such outlet tap as shall be entirely independent of the inlet.

27.—None but screw-down taps, incapable of being suddenly closed, shall be fixed on pipes supplied direct from the main.

28.—Any standpipe fixed for the use of the occupants of more than one house must be fitted with a self-closing apparatus incapable of being suddenly shut.

29.—The Corporation will provide and fix all water meters for the supply of water for trade purposes, and will also lay the service pipe from the boundary of the premises to the inlet of the meter, and fix the stopcock thereon, at the expense of the occupier of the premises.

30.—No steam boiler, or any description of closed boiler, will be allowed to be supplied direct from a service pipe; but the supply will be given through a meter, and a self-acting check valve must in every case be fixed on the pipe, so as to prevent a return of the water.

31.—Hydrants for fire or other purposes inside premises can only be permitted by the special sanction of the Water Committee, for which application must be made in every case.

32.—Before a connection for the supply of water can be made, or before any additional fittings can be connected to an existing service pipe, the work must be inspected and approved by the proper officer of the Corporation.

33.—Printed forms will, upon application, be furnished to plumbers who have signed an agreement to conform to the regulations, which they will be required to fill up and deliver at the Engineer's offices, as notices of fittings being ready for inspection, and also of any alterations made in existing service pipes or fittings, and such notices must be given before pipes or other fittings are covered.

Instructions to Plumbers as to Repairs of Defective Fittings.

All existing fittings which are so far defective that they cannot be effectually repaired to the satisfaction of the Engineer, must be replaced by stamped fittings, in all respects in conformity with the preceding regulations.

The attention of Plumbers is directed to the following special cases:—

Any single valve regulating cistern, if found to be causing a waste of water after having, on a former occasion, been repaired on account of waste, shall, if the two periods of waste have occurred within twelve months, be replaced by a stamped cistern.

Common cocks (whether bib-cocks, stop-cocks, lever-handled, or weighted cocks) to water-closets when found to be wasting water, or left open through carelessness, must be replaced by stamped cisterns.

Whenever a leakage arises in, or repairs have to be effected to a ball-cock, in a cistern of which the overflow is connected with a drain or flush pipe, the existing overflow must be cut off and brought to the outside, in accordance with regulation 12.

Such underground cisterns as may cause unseen waste shall, if found to lead to waste in any case, be abolished.

George F. Deacon,
Water Engineer.

Municipal Office, Dale Street.

Notice to Plumbers.

As there appears to be some misapprehension concerning the operation of the Regulations of the Corporation in regard to By-Pass Pipes, Overflow Pipes, and Cisterns, the following explanations are issued for the guidance of Plumbers:—

As to Regulation No. 9—By-Pass Pipes.

In all cases where two or more houses are supplied from one cistern, and there is no tap supplied direct from the main, a connection must be made between the inlet and outlet pipes, so that during periods of constant service the water may flow direct from the main to the inside pipes. This may be done in one or two ways:—

(a) By a pipe joining the inlet to the outlet pipes, and provided with stopcocks to enable the water to be turned either into the cistern or direct into the outlet pipes without entering the cistern.

(b) By a pipe joining to the outlet of the ball cock, and to the outlet of the cistern by means of brass unions; the union at the outlet to have a lock nut. A sketch of this arrangement will be shewn on application at this office. Ball cocks specially adapted for the purpose will have to be provided, and must, together with the unions, be stamped by the Corporation Testing Officer.

All pipes and taps used in houses where the by-pass arrangement is applied, must be of the kind required for direct communication with the main.

As to Regulation No. 19.—Overflow Pipes.

Overflow pipes must not be laid into back yards or on to roofs, but must be brought to the outside of the premises to which they belong, in accordance with Regulation No. 19.

No departure from this regulation will be allowed without permission being given in writing.

As to the Fixing of Water Closet Cisterns.

Numerous cases have been reported where water closet cisterns, in new houses, have been fixed on single bearers, and the covers have been allowed to rest against the walls of the closets. This arrangement is objectionable. The cisterns should be firmly supported, and set in a level position without being supported by the walls of the closets. The covers should be screwed on when the cisterns are properly fixed, and should be capable of easy removal.

As to the Covers of Storage Cisterns.

Regulation No. 22 requires every storage cistern to be "made capable of easy inspection." To carry out this regulation the cover of every large cistern should have an opening over the ball cock with a lid, fastened with screws, so that it may be readily removed to examine the interior of the cistern and ball cock without removing the large cover.

George F. Deacon,
Water Engineer.

It is to be specially noticed that in many cases the authorities state that only such plumbers as are certified by them shall be employed by the consumers, and I am informed that in one case where a plumber had been suspended, he attempted, by action at law, to obtain a reversal of his suspension, but that this action on his part was successfully resisted. How far this procedure is really authoritative I am unable to state. In most cases the authorities content themselves with publishing a list of plumbers who have signed an agreement with the Corporation or Company, by which they bind themselves to adhere to the Regulations on pain of having their names struck off from the list of authorised plumbers if they neglect to do so; but in these cases the Corporations and Companies do not appear to consider that they have any right to insist on the employment of the plumbers whose names appear on these lists, and these only.

It seems most desirable, in the interests of the consumer, as well as of the Water Company, that only reliable plumbers should be employed, and if the Company has power to make regulations as to the supply of water, and to refuse to afford such supply unless certain conditions are complied with, one of these conditions may reasonably be, that only plumbers who agree to work in accordance with certain regulations, and who will be responsible for the excellence of their work, shall be employed; it does not appear, however, that such exclusive employment is insisted on in the majority of cases, though it is strongly recommended.

4. All fittings must be tested and stamped. This is a general, but by no means universal requirement; in many cases it is

stipulated that the valves and other apparatus shall be approved by the Company; in some instances no stipulation whatever is made on this head. It seems desirable that water fittings should be of the best quality, and that each fitting should be stamped by the water authority, who should be responsible for its workmanship, and for its fitness for its purpose. It would probably be more convenient still if each Corporation or Company were to supply these fittings at trade prices; but this practice might have a tendency to stereotype designs, and to prevent the introduction of new and improved patterns.

5. A set of standard fittings is exhibited in the stamping office, and the engineer will examine any other fittings and decide whether they may be used or not.

This seems to be a universal provision when stamping is compulsory and is only just.

In the Glasgow Corporation Water Works Regulations, a list of dimensions of taps and fittings is supplied in the following form.

The taps must not be less than of the following weights and dimensions:—

	Size of Taps.				
	⅜-in.	½-in.	⅝-in.	¾-in.	1-in.
Screw-down Loose-valve Nose-cocks & Stop-cocks	9½ ozs.	12½ ozs	16½ ozs.	21 ozs.	35 ozs.
Diaphragm Nose-cocks and Stop-cocks	10½ „	14 „	18 „	23 „	39 „
Double-valve Nose-cocks	11¼ „	14½ „	18½ „	22¾ „	
Screw-down Loose-valve Tube-cocks	.....	.....	27 „		
Diaphragm Tube-cocks	.....	.....	28½ „		
Outside diameter of tube	.....	.....	1⅝ ins.		
Underground Stop-cocks—					
Weight	.....	24½ „	.....	35 „	54 „
Length of Cocks	.....	5¾ ins.	.....	5¾ ins.	6½ ins.
Ferrules—					
Weight	.....	.....	.....	8 ozs.	14½ ozs.
No. of threads of screw to the inch	.....	.....	.....	14	11
Stop-cock boxes, 8 in. high.					
Weight	.....	.....	28 lbs.		

All taps must have the maker's name stamped upon them.

6. All service pipes shall be of lead and every joint shall be wiped.

Lead pipes are required by the majority of companies, and in a few cases these are specified to be tinned; in a few instances wrought-iron pipes are permitted, and in one or two

cast-iron pipes may be used; but wherever lead pipes are required wiped joints must be made.

7. All service pipes must be laid at least 2 ft. 6 in. below the ground.

This depth varies in different places from 1 ft. 6 in. to 3 ft.

8. Lead service pipes must be of certain dimensions. In this case the smallest pipe permitted is $\frac{3}{8}$ in.; most of the companies do not allow of a smaller diameter for a service pipe than $\frac{1}{2}$ in., and specify that where a $\frac{3}{8}$ in. pipe is used only one tap may be placed upon it.

9. That each house or block of small houses should have its own separate supply is an almost universal stipulation and a reasonable one.

10. This regulation provides for the weight per yard of the lead pipe used for supply—such weight varies with the pressure of water maintained in the mains. Pipes not under pressure may be of lighter weight.

12. Pipes may not be laid through any drain, &c., unless provided with an exterior cast-iron casing. This is a universal and necessary requirement.

13. No pipe shall be brought above the level of the ground outside any building, unless properly protected from injury and frost.

No exception can be taken to this regulation.

14. Outside stop-cocks are in this case fixed by the corporation. In many cases they are only recommended, and in others they must be fixed at the expense of the consumer.

It is, I should say, desirable that the use of stop-cocks should be compulsory, and that they should be fixed by and at the expense of the corporation or company.

15. The supply for drinking and culinary purposes shall be drawn direct from the main.

It is most desirable that this stipulation should be universal, but this can only be done by making constant supply universal.

16. Storage Cisterns. In the regulations of the Liverpool Corporation, where a bath or hot-water apparatus is used, the cistern must be capable of containing 50 gallons, in other cases 25 gallons. In many instances it is provided that cisterns to contain a day's supply shall be provided—which is a very indefinite term—in others, no provision is made.

17. Cisterns shall be strong, and if constructed of wood shall be lined with lead, weighing at least 5 lbs. to the square foot; the ball valve shall be securely fixed to the cistern, and shall not be submerged when the cistern is full, and the level of the water at such time shall be 3 ins. below the overflow.

18. Domestic boilers, water-closets, and urinals must in all

cases be supplied from cisterns. Such cisterns shall either be on the alternating valve principle, and capable of delivering two gallons at each flush in 15 seconds, or otherwise so arranged as to produce the same result; but no valve except the ball valve shall have a greater pressure on it than that due to the head of water in the cistern.

In many of the regulations it is provided that for closets and urinals water shall only be drawn from a two gallon cistern, whether separate from or attached to the main cistern; such supplementary cistern to be provided with valves, which shall not admit water to the cistern at the same time as it flows from it. No doubt this arrangement is the best for insuring that only two gallons of water shall be used at each flush, but unless the inlet to the cistern is of considerable dimensions, which is not usually the case, when the closet or urinal is used in quick succession on the second using the cistern is not full, and the closet or urinal is not sufficiently flushed.

19. Overflows from cisterns shall act only as warning pipes, they shall not discharge over any ash-pit. This provision precludes the use of a standing waste, or other arrangement by which the cistern may be readily emptied and cleaned, and it is preferable that a ground valve should be permitted in the bottom of the cistern, in order that it may be easily cleaned out, such ground valve to communicate with a rainwater head, and thence, but indirectly, with a gully.

20. No water pipe shall communicate with a rain-water cistern.

This regulation requires no comment.

21. No cistern for domestic purposes shall be placed below the surface of the ground.

This is a general specification.

22. Every cistern shall be in an accessible position, and made capable of easy inspection.

As here specified, this requirement can be met with facility, but when it is stated that every cistern must be securely covered, and must be easy of inspection, some explanation is necessary, and this is given in one or two cases, and the requirement is stated to mean that a good cover must be fitted to every cistern, and a small door provided in it by which access can be obtained to the ball cock. It must be obvious that such an arrangement as this makes it exceedingly difficult to clean the cistern, or to see if it requires cleaning.

23. Cisterns must be protected from frost.

24. The pans or basins of water-closets must be of a specified form; the flushing pipe, except in the case of pan closets provided with cisterns having a fall of at least 8 ft., must be

1¼ in. in diameter; in the latter case they may be 1 in. in diameter, and in pan closets the pan must be able to sustain a weight of 7 lbs.

If closets are amongst the standard fittings which must be approved, as they certainly should be, this and the following clause, so far as closets are concerned, are useless; and if closets must be approved, any regulations with regard to pan closets might be omitted, as they ought not to be passed by any engineer.

25. Trough closets to be approved by the engineer.

26. Every bath shall be provided with a water-tight plug or valve unconnected with the inlet valve.

This clause is meagre and does not compare well with the requirements of many other places where it is specified that the inlets shall be above the highest water level in the bath, and that there shall be no overflow other than such as will act as a warning of waste.

27. None but screw-down or slow-closing taps shall be fixed on the main or pipes connected directly with it.

28. Any stand pipe used by more than one house must be provided with self-closing apparatus, incapable of being suddenly shut. This appears to be necessary in the case of any stand pipe, whether used by one or more houses.

—The remaining clauses, Nos. 29 to 33, and the instructions to plumbers with regard to defective pipes and fittings, do not call for any remark, they appear to be common sense and reasonable requirements, though, considering the powers claimed, it might be expected that only water-closets of approved pattern would be permitted, and that direct connection between cisterns used for domestic supply and closets would be condemned.

The second instance of a series of regulations which has been taken to illustrate this paper, is that of the Chelsea Water Co., and forms a great contrast to the above. In the regulations of the Liverpool corporation there are thirty-three clauses besides instructions to plumbers with regard to defective fittings and explanatory notes, whereas in those of the Chelsea Water Co. there are only seven clauses, lettered from A to G, and corresponding generally with Nos. 17, 18, 19, 20, 21, and 26, and may be shortly summarised as follows:—

A. Every cistern shall be water-tight. Separate cisterns for baths, closets, and hot-water apparatus, are recommended.

B. Underground cisterns and wooden cisterns without metallic lining are not permitted.

C. Each cistern must be provided with a ball-valve, securely fixed to the side of the cistern, the highest level of water not to submerge the ball, and to be 2 ins. below the warning pipe.

D. No waste pipes are permitted other than warning pipes, which must not be connected with any drain.

E. Taps to be of the best screw-down kind, and in accordance with sample.

F. Water-closets and urinals must be supplied only through a cistern or service-box, or other approved waste-preventing apparatus. Stool-cocks and T taps are prohibited, and there shall be no direct connection between any closet and the Company's pipes.

G. The inlet of a bath must be distinct from the outlet, and it must be placed above the highest water-level in the bath. Every outlet shall be provided with a water-tight plug or valve. No bath shall have any overflow other than a warning pipe.

Where the regulations are full and explicit, although they are primarily directed to prevent waste of the Companies' water, yet they also act fairly, though not completely, as safeguards to the consumer from a sanitary point of view. This cannot however be said of the short and incomplete regulations —they are directed almost entirely against waste of water.

I may suggest that it would be advantageous if all regulations could be assimilated, with such slight modifications only as are necessitated by local requirements.

I append certain regulations of the Manchester Corporation Water Works which are worthy of consideration. Regulation No. 15, by which urinals may be flushed direct from the service pipe if a self-closing tap be used, does not appear to be judicious.

4. On and after the first of January, 1879, all Stop Cocks to be fixed on service pipes must be of *larger diameter than such pipes:*—for instance, ⅜ inch pipes must have ½ inch Stop Cocks; ½ inch pipes, ¾ inch Stop Cocks; ¾ inch pipes, 1 inch Stop Cocks; and 1 inch pipes, 1¼ inch Stop Cocks.

13. No Tap for domestic purposes in Dwelling-Houses, or for drinking purposes in Warehouses, will be allowed to be supplied from a Cistern, but in all such cases Drawing-Off Taps must be fixed on the Service Pipe before it enters the Cistern; Baths, Water Closets, Urinals, and Wash Basins only are allowed to be supplied from a Cistern.

15. Urinals may either be supplied by a Self-closing Tap, of approved description, from the Service Pipe before it reaches the Cistern, or by a Urinal Cistern of approved pattern.

27. The Waterworks' Committee will provide and fix all Water Meters, and will also lay the Service Pipes from the boundary of the premises to the inlet of the Meters and fix the Stop Cocks thereon, at the expense of the occupier of the premises, and such inlet Pipe and Stop Tap must not be interfered with by Authorized Plumbers or any other persons, without the sanction of Superintendent or other authorized Officer of the Waterworks' Committee.

30. Information from Authorized Plumbers, or other parties, as to any infringements of the preceding instructions will receive the immediate attention of the Committee.

31. Authorized Plumbers will be struck off the Lists if found lending their names to unauthorized persons.

34. All Taps (with the exception of those specially allowed as per Regulations Nos. 9 and 15) must be on the screw-down principle, with loose valves

and stuffing boxes; the diameter of all orifices in the seats on which the valves work in the *Taps* to be the same size as the Taps themselves; and all Taps must be capable of resisting a pressure of 300 lbs. to the square inch, to which they will be subjected in testing.

35. The Bib and Stop Taps must be of the following average weights, viz.:—

1 inch	32¼	ounces.
¾ „	21	„
½ „	11½	„
⅜ „	8½	„

Double Valve Bib Taps—

¾ inch	22¾	ounces.
½ „	13¼	„
⅜ „	10¼	„

36. Ball Taps must be of the best quality, and the diameter of the Tap and Ball as under:—

1 inch	diameter of Tap,	not less than	6 inches	diameter of Ball.
¾	„	„	5½	„
½	„	„	4½	„
⅜	„	„	4½	„

37. The Rods or Spindles from the Balls to the Taps must not be less than the following lengths:—

1 inch diameter of Tap	13	inches long.
¾ „	13	„
½ „	11	„
⅜ „	11	„

38. The Strength of such Rods must not be less than as follows:—

End next the Tap.	*End next the Ball.*
1 inch ¼ by 5/32 inch	¼ by 7/32 inch.
¾ „ 13/64 by 3/16 „	ditto.
½ „ 13/64 by 6/32 „	⅛ by 4/32 inch.
⅜ „ 11/64 by 5/32 „	ditto.

The Rods or Spindles referred to above may be of the following strength, in lieu of those stated, viz., 4/16 by 2/16 inch.

39. Such Taps without Balls or Spindles must not be less than the following weights:—

1 inch	22½	ounces.
¾ „	10½	„
½ „	7¼	„

Ferrule Taps for Baths.

40. The weight required in future by the Waterworks' Committee for the above Taps *without the handle* will be 20 ounces, and no Taps of this nature will be passed and Stamped of lighter weight.

Specification for Double Valve Cisterns, and various parts thereof.

(Referred to in Regulation 17.)

1. The 73 x and 73 n t Cisterns to give two gallons of water each flush, and to be so constructed as to contain two gallons two inches below the overflow or tell-tale pipe.
2. The Valves to be of lead with brass lining, and brass faces for the Indiarubber Washer.
3. The Valves in 73 x and Small Valves in 73 n t Cisterns to weigh not less than 2 lbs. each, and the Large Valves in 73 n t to weigh not less than 3¼ lbs. each.
4. The Valve Rods to be of Brass, and not less than 3/32 in. in thickness,

and to have a strong brass nut screwed and riveted on to the bottom, a loose brass washer to be placed above the nut in order to take the wear which arises through the Valve being suddenly and repeatedly lifted.
5. The Indiarubber Washer to be of the best quality, and not less than ⅛ in. thick.
6. The Valve Seats inside Cisterns to be of brass, and fastened down by a strong lock nut and union. The bearing on the bottom of the Cistern to be not less than ½ in.
7. The bearing of the Valve Rods to be of brass, and the female bearing of Cistern Levers to be bushed with brass ¼ in. in thickness.
8. The Cisterns to measure 18 in. in length, inside measure, so as to allow the rod of the Ball Tap to be of the proper length.
9. The Indiarubber Buffers to be fixed on the top of the Cisterns instead of being at the underside of the lever.
10. The Trapping Box of 73 n t Cisterns to be supplied through 2½ in. orifice with a proper Valve not less than 3 in. in diameter.
11. The fall or outlet pipe of both 73 x and 73 n t Cisterns to be not less than 1½ in. internal diameter. The pipe in trapping box to be of brass, and to be directly under the outlet valve.
12. The 73 n t Cisterns, Valves and Lever inclusive, to weigh not less than 85 lbs. each, without cover.
13. The 73 x Cisterns, Valves and Lever inclusive, to weigh not less than 65 lbs. each, without cover.
14. Cisterns will only be approved that are constructed in accordance with the foregoing specification.
15. A sample Cistern in accordance with this specification may be seen at the Waterworks' Testing and Stamping Office, Town Hall, Manchester.

Specification for Syphon Cisterns for Water Closets.

1. The Cisterns are not to discharge more than two gallons of water at one flush, whether the pull be quick or slow.
2. The discharge pipe, or under side of the syphon bend pipe, must not be less than ⅛ inch above the side of the Cistern, so that in case of leakage from the Ball Tap, while the Cistern is not in action, the water shall overflow the side of the Cistern and not go down the discharge pipe, but this must not in any way interfere with the existing Regulations as to overflow pipes. There must be no connection with the Cistern and discharge pipe other than the syphon, which must be capable of being brought into action when the water level is at least one inch below the overflow pipe.
3. All working parts liable to corrosion must be made of, or faced with, Gun Metal, or other approved material *not liable to corrode*, and should the syphon or part of it be of Iron it must be of such weight and dimensions as shall in no way lessen the effective working of the Cistern in case of corrosion taking place.
4. No Cistern with piston or other action requiring a quick or sudden pull to start the syphon will be allowed, nor any Cistern that is not capable of being brought into action with a gentle pull or drop of the lever.
5. No Cistern will be approved where there is any decrease in the force of the flush during the discharge of the quantity of water allowed, or which by manipulation of the pull or lever or any contrivance allows a constant flow of water to the closet.
6. All appliances for the discharge of water must be of the simplest kind and not liable easily to get out of order, and be such as can be readily repaired; they must also work with little noise or jar.
7. Iron Syphon Cisterns must have round corners, inside and outside, as a protection against frost.
8. Such Cisterns must be made of the following strength, viz.:—to gauge ¼ inch at the top tapering to 3/16 inch at the bottom.
9. All Cisterns must be 18 inches in length.

Mr. Rogers Field (London) drew attention to the two-gallon system of flushing water-closets. He admitted that it was quite possible for two gallons of water to be sufficient for this purpose, but though the cisterns were of the two-gallon measure they very seldom got the full two gallons of water from them. The sanitary object desired to be gained was this, not merely that there should be sufficient water to flush out what there was in the closet, but that there should be sufficient to carry it away from the house. Possibly, as he had said, they could manage with two gallons for this purpose, but generally they wanted more; but with a hard and fast rule like this, confining the cistern to the two gallons, what were they to do? To be sure they had no desire to waste water, but did the two-gallon cistern prevent a waste? He held that it did not, for a careful person finding the first flush insufficient would wait until the cistern was re-filled, and then flush again. So that really they were not saving water by this system. In Scotland it was the rule for cisterns to hold four gallons, and it seemed to him very necessary that it should be urged on authorities to provide a larger quantity of water, for the point was a very vital one. There were certain closets for which a small quantity was perfectly inadequate. He did not know what regulation prevailed in Brighton in this respect, but if the Corporation confined their cisterns to two gallons he earnestly urged them to alter the system. Another thing he held was that water pipes should on no account be allowed to pass through drains. Nothing was more dangerous. Then with regard to the opinion that had been expressed about pan closets. He quite agreed with it, and he thought if the authorities of Brighton and Hove resolutely set their faces against their use they would very soon get rid of them.

The President of the section asked Mr. Field if, as a sanitarian of great experience, he quite agreed with the legislation that only allowed lead pipes to be used in connection with the water supply in houses?

To which Mr. Field replied that he did not, as water in some cases very seriously affects lead. It was much better in such cases to use iron.

Mr. Wm. White (London) also considered it very injudicious to enforce the use of lead pipes in all cases, and more especially in those cases where there was not a constant flow of water through the pipes. He had known two miles of lead pipe kept perfectly free for many years with soft water flowing through them, but then the pipe was not stopped up at its ends at all. Its purpose was to keep the cisterns in a small village filled with water, and he was asked his opinion about it at the time—nearly twenty years ago—and he believed the pipe was still in perfect use. He was glad that Mr. Field had called attention to the sanitary defect—chiefly emanating from water companies—which limited the flushing of a closet to two gallons. He thought that a full two and a half gallons should be the minimum quantity, and he rather thought that not less than three gallons

should be allowed with option to the management of the cistern. Many people had a great difficulty in keeping their cisterns clean. If the cistern had not a cover it was very liable to collect dust.

Mr. Wray (Brighton) explained that the regulation in Brighton was that their water supply should be such as was satisfactory to their Borough Surveyor. Their cisterns held never less than two gallons, and as a matter of fact three or four-gallon cisterns were often adopted. With reference to pan closets they did not allow them to be put into new buildings, and when it was brought to the notice of the Sanitary Committee that any of those in use were in a bad state they had them taken out. It would be understood, he thought, that in some cases they had to use powers of persuasion in the attainment of this end in preference to going about the matter peremptorily. He thought if The Sanitary Institute were to come to Brighton again in a few years' time they would be able to see that all their sanitary details and principles were as near perfection as possible.

Mr. Baldwin Latham (London) agreed with Mr. Field about the desirability of having larger cisterns, and he explained that the two-gallon system was due to an Act of Parliament framed with reference to the metropolis. The Board of Trade had had the power to make the regulation, which, he stated, had been arrived at after considerable investigation and enquiry in very many towns. It was quite clear to him that, having regard to the great length of main drains, it was very desirable indeed that the quantity of water should be sufficient completely to carry away all matters which accumulated. With regard to leaden pipes, they were in some cases very injurious, and especially had they proved so in Yorkshire, where they had had a great deal of trouble from the poisonous character of certain of the waters. It was somewhat curious that this poisonous character was not always the same. For some years they would have lead poisoning taking place, whilst in other periods it would not occur at all. When the Board of Health started they had an idea that everything should be in iron. Croydon was one of the towns which had its water service entirely in iron, and the result was that when the pipes were laid under the ground level they would in a very short time—a fortnight in some cases—be eaten through so as to leak. At the time it gave them great trouble and anxiety to know if they could substitute lead for iron. At last all the iron pipes were taken up and lead ones put in their place. This evil of subterranean leakage was most dangerous. In one case where the pipes went under a slaughter house there was a leakage and the whole of the neighbourhood could draw nothing from their taps but blood and water, the soakage and washage from the slaughter house having been drawn into the pipe and polluted the whole of the water supply. When lead was used, only those towns like Brighton and Croydon which had a chalk water supply, were entirely free from the danger of lead poisoning. Indeed, he was of

opinion that chalk supplies would probably be found the ultimate remedy for the injurious effects of both iron and lead. The water of the Bagshot sand was equally liable to affect lead, and in that case of course some other means would have to be taken and other materials substituted. Above ground there could be no objection to using iron in many cases, nor was it now insisted that all joints in pipes should be plumbers' joints. In fact it was much cheaper and equally if not more advantageous to use cone joints. It was essential that some regulation should be adopted to prevent contamination with sewage and foul matters, and one step in attaining that end would be gained by abandoning intermittent supplies.

On "Brighton as a Health Resort." A short review of the various Works executed from the year 1858 *to the year* 1890, *by the Engineer and Surveyor's Department of the Corporation of Brighton acting by the Council as the Urban Sanitary Authority for the Borough. By* FRANCIS J. C. MAY, Assoc.M.Inst.C.E., Borough Engineer and Surveyor.

BRIGHTON, a "Health Resort," is the title of this paper, and my object is to show, from an Engineer's point of view, how the town is by nature pre-eminently qualified to hold that title; this position has been duly recognised by successive generations of the inhabitants, of which each has done its best, according to the knowledge of its respective age, to promote the health, comfort and pleasure of its visitors, and at the same time to further the best interests of the town; but it is my intention to refer more particularly to the improvements achieved during the last thirty years, that being the period which has been devoted more especially to the study and practice of the laws of sanitation in relation to the person, the dwelling, and the town. During this period the Corporation of Brighton has continually persevered with indomitable courage to keep well to the front in all sanitary and useful measures, spending liberally yet wisely, sparing no expense to preserve and improve the natural beauties and advantages of the place, and making a profitable use of the rapid strides in the knowledge of sanitary science generally. From the year 1858 to the end of the year 1889 my respected predecessor, Mr. Philip

C. Lockwood, M.Inst.C.E., was Engineer and Surveyor. He most ably and wisely advised and assisted the Corporation in all their deliberations, and afterwards devised and carried out their great works in the most scientific and faithful manner. This unbroken length of service of the Engineer and Surveyor, in my opinion, contributed in no small degree to secure the general success of the various improvement schemes that have from time to time been promoted—one master mind having arranged the whole work, whereby the proverbial spoiling of the broth by the meddling of too many cooks has been avoided. With this short introduction, I now proceed to the matter of the paper.

The situation of Brighton is in 50° 55′ N. latitude, and about 3′ W. longitude on the eastern side of a shallow bay of the south coast; the centre of the town is in a valley, sheltered from the piercing north and east winds by the Sussex Downs, and facing nearly due west, which renders it a most desirable residence during the inclement weather so prevalent in our climate from September to the end of April, or even later. For this reason it is indeed a "health" resort to all those persons whose constitutions suffer from the severity of winter weather, and who can afford to choose their own residences, or have the opportunity of occasionally enjoying a change of air.

The soil is also very favourable from the "health" point of view. That to the east, north, and north-west is principally a thick sub-stratum of chalk, covered with a thin layer of earth. The subsoil of the centre is marl and shingle, while to the westward there are large beds of clay of a very irregular character. The surface of the land is very undulating, and the town therefore presents a succession of hills and valleys in every direction, as may be understood by studying the levels marked on the contour map. This gives rise to the opinion often expressed, that Brighton in respect to temperature, and the sensation of cold, offers a great variety of climate according as the situations are more or less elevated, sheltered, or exposed. I would here remark that, when the wind is in the north or east, the Madeira Road under the East Cliff offers to the invalid a climate suggestive of the air of the island from whence its name is derived.

While the sea, with its fishing, boating, and bathing facilities, is one of the great attractions of Brighton, it has also been its greatest foe. Lying in such a situation as to be open to the fury of the violent south-west and westerly gales, Brighton has from time immemorial suffered seriously from the encroachments of the sea. Although these inroads have been very extensive, it appears that the skill of the engineer to combat

with them was not enlisted till after the storm in the year 1713, when the first timber groynes were built westward from the Old Steine. Those eastward as far as Black Rock are of more modern construction, commencing about the year 1819, the sea at that date making rapid inroads upon the whole of the cliffs of the Marine Parade. The money required for these sea defences was raised by means of a coal duty of 2s. 6d. per ton on all coals brought into the town, under the Brighton Town Act of 1810, but these dues ceased on September 13th, 1887. After the construction of these groynes, the building of a sea wall was easily accomplished. The first portion formed was that between West Street and Middle Street, and was opened by King George IV. in the year 1821. The fine old sea wall along the Marine Parade, which is built of lime concrete (at that date quite a novelty), the work of Mr. W. Lambert, was completed in the year 1835, at a cost of upwards of £100,000. The wall, one mile and one quarter in length, is in many places sixty feet high, twenty-three feet thick at its base, and batters on an average four inches to the foot on the face. After this great work was completed, no other work of importance was undertaken till after the year 1858 (the period of which I am going to write more in detail). The government of the town, nearly up to this period, was by a body of Commissioners, of whom the High Constable was chief; but in the year 1854 the town was incorporated, and after this date a greater degree of energy and prosperity set in. In the year 1858 Mr. Lockwood was appointed Borough Surveyor. On his retirement, in the year 1889, he was appointed Consulting Engineer to the Corporation, and in that capacity has superintended the more recent addition on the Madeira Road.

The system of groyning, adopted by Mr. Lockwood since the year 1858, has resulted in the reclamation of twenty-three acres of land from the sea, which has enabled the Corporation to increase the width of the carriage-ways and esplanades on the front to their present noble proportions, besides securing the splendid stretch of beach now to be seen.

The Esplanade on the King's Road has been widened three times. The Corporation has thus secured to the town a noble sea-front, nearly three miles in length, with a carriage-way on the top of the cliff of an average width of 53 feet, with an Esplanade and Parade about 40 feet wide; while under the cliff there is an Esplanade from the Western boundary to the Albion Groyne, opposite the Aquarium, about 20 feet in width, and eastwards therefrom a carriage-way, with a foot-path known as the Madeira Road, from the Aquarium to a point opposite Sussex Square, near which place a junction is formed with the

upper road by means of an inclined road, of a total width of 60 feet.

The widening of the sea-front has been effected by forming arches to carry the roadways, and these arches form pleasant retreats or lounges, having a good view of the sea, and are much enjoyed and sought after by both residents and visitors. This is a very novel feature, and well worth a visit; some of the arches are fitted up in a most luxurious style.

In the month of May this year a further improvement was effected in the Madeira Road. It comprises a commodious Shelter Hall, embracing every convenience one can reasonably desire, with a covered walk 1250 feet in length, of which the roof forms a terrace promenade, which may be approached by the elegant lift, which enables persons or invalids in bath chairs to ascend or descend from the Marine Parade on the cliff to the Madeira Road below, without the fatigue formerly experienced by climbing the long flight of steps. This improvement cost the Corporation upwards of £15,000.

The whole of the splendid sea-front promenade from East to West is brilliantly lighted at night by 180 Suggs' lamps, burning 30 cubic feet of gas per hour each.

From the year 1860 upwards of £2,000 also has been spent in providing seats for the comfort of the people on the front. Shelter from the weather, rest for the weary and the invalid, has been provided in abundance, together with every convenience and sanitary arrangement to promote their cleanliness, health, and comfort while taking exercise and enjoying the sea breezes to recuperate their strength of mind and body. With a view to prevent pollution of the air, special attention is given to the cleansing of the carriage ways and cab-stands on the sea-front and in the principal streets. In addition to the ordinary methods of scavenging, a system of street orderlies has been adopted, by which means the horse droppings, and everything of a like objectionable character, is removed from the surface of the roadway as quickly as possible. The cab-stands (about three miles in length) are all formed of cement concrete, and are kept in a cleanly condition by frequent and copious washings. The pavements are frequently and regularly swept, and the sea-beach is kept in good condition by the daily removal of all sea-weed, decaying matter, and refuse of all kinds likely to be detrimental to health, or offensive to sight or smell. Nearly £4,000 has been spent in the formation of paved cab-stands on the front during the same period.

This long list of improvements on the front, exclusive of groynes or sea-walls, has cost the total sum of nearly £75,000 (as per table at end); but there has also been an infinite

number of minor improvements within the Borough which it is impossible to mention within the scope of this paper, and of which the total would represent a still further large sum. I have therefore confined my remarks to the improvements on the sea-front. These grand works are protected from further inroads of the sea by six concrete groynes and fifteen timber groynes, constructed between the years 1862 and 1888, at a total cost of over £75,000, of which the details will be found among the tables at the end of this paper.

The street improvements are far too numerous and varied to be named separately, but some idea of their magnitude may be realized from the fact that upwards of £30,000 has been spent between the years 1860 and 1890 in the most prominent places alone.

The Corporation of Brighton has been fully alive to the importance of the fulfilment of its duty to provide open spaces as the lungs of the Borough. The parochial graveyards have been levelled, laid out with walks, planted with trees, and provided with seats, by which means they have become useful open spaces, and are greatly appreciated. "The Level," an open space of more than 10 acres, lying between the London and Lewes Roads, quite in the centre of the town, was in the year 1877 taken in hand, and by the judicious outlay of about £2,000 rendered a most delightful public recreation ground. In the year 1879, the Corporation received from the Executors of the late W. E. Davies, Esq.—all honour to his memory!—the munificent bequest of the princely sum of £70,000, to be applied by them at their discretion for the benefit of the town, and with this money "Preston Park" was purchased in 1882, at a cost of £50,000. It contains about 60 acres of land, and has since been laid out for the use and pleasure of all grades of the public in the most attractive manner, at a further cost of about £15,000. There are to be found cricket grounds, tennis lawns, cycle tracks, "Rotten Row" for equestrians, walks and drives, chalets, and every public and sanitary convenience for the comfort and health of all ages and sections of society. By the munificent gift of the Race Stand Trustees (Messrs. Alderman Abbey, Brigden and Ridley, and Seymour Burrows, Esq.) the Fee Simple of "The Race Hill," or "Tenantry Down," containing about 105 acres of land, was acquired for the public use (previously to this the public had only the right of walking over the land) on the easternmost boundary of the Borough, and forms the most delightful and healthful resort that can be imagined, being an interesting portion of the noted South Downs. Here are to be found most magnificent and extensive views over land and water, with

health-giving balmy air of the Downs, or ozone from the sea—altogether a most lovely, quiet retreat. Quite recently "The Queen's Park," which is situated in the centre of the thickly populated eastern wing of the town, has also been presented to the town by the Race Stand Trustees. It contains about 21 acres, and was purchased by the Trustees at a cost of £13,500. Plans have been prepared for its disposal as a public recreation ground and botanical garden, of which the cost is estimated at £4,000. When completed, this, from the undulating and otherwise suitable character of the land, will be the prettiest of all the public recreation grounds of the Borough. Too much praise cannot be given to the Race Stand Trustees for their untiring efforts to secure these two magnificent gifts for the benefit of the public of this important Borough.

Sanitary Measures.

The Borough Sanatorium and Disinfecting Station, which may be considered as a temporary building (to be superseded soon by one on a larger scale, and of a permanent character), was erected in the year 1881, and with additions since has cost about £10,000. In the Spring of the present year the first section of the permanent work was completed at a further cost of £1,811. It consists of a well-appointed steam laundry, designed in all its parts on the most modern principles, and is as perfect and convenient as modern science has yet devised. The Sanitorium is situated on an eminence of over 300 feet above Ordnance Datum on the North-eastern corner of the Borough boundary. Although the buildings are of a temporary character from the fact that they had to be erected in great haste owing to fears entertained at that date of an epidemic (which fortunately did not occur), yet they are thoroughly well-appointed in their internal arrangements. There is also an efficient staff, and under the able supervision of the energetic Medical Officer of Health (Dr. Newsholme), it is one of the most useful Institutions in the Borough.

The drainage system of the Borough may justly be considered one of the most important sections of the sanitary work of the Engineer and Surveyor's Department. In the year 1860 there were 11 miles of sewers in the streets. There are at the present date 72¼ miles. The importance of this question to such a town as Brighton was from the first thoroughly recognised, and the following eminent engineers were consulted on the subject:—Sir Robert Rawlinson, Sir John Hawkshaw, Sir Joseph Bazalgette, Mr. Hawksley, and Messrs. Bright and McLean, in conjunction with Mr. Lockwood. The result of the combined wisdom and experience of these illustrious men

has been the adoption of what we claim may be considered as one of the best systems of main sewers. Such old sewers as were found defective were abolished and replaced by new; those which were sound were ventilated and otherwise adapted to the new system. The cost of the main sewers was about £120,000. Great care was taken in the construction of the new sewers to ensure the use of the best materials of their several kinds, and the laying of the pipes with sound joints and true gradients to render them as nearly self-cleansing as possible. This was no slight task, owing to the steep gradients of many of the streets, in some of which it was found necessary to lay the sewers in a series of steps. The sewers have been so arranged in districts or sections for ventilation, as to cut off those of the lower from the higher level.

The system as first constructed had three outfalls into the sea, one at each boundary of the Borough—east and west—and one about midway between the boundaries and opposite the Albion Hotel; but in the year 1869, Sir John Hawkshaw designed the great Intercepting Sewer, which is laid along the whole front from the Western boundary of Hove to the outfall at Portobello, a length of 7¼ miles, and 3·87 miles distant from the Eastern boundary of Brighton. This Intercepting Sewer is formed in three sections; it is built of brickwork in cement as follows:—

9,918 feet of 5 feet sewer.
700 „ 6 „ „
27,826 „ 7 „ „

The fall is 1 in 1760, or 3 feet to the mile.

The cost of the Intercepting Sewer was £104,608; it was commenced in 1871 and finished in 1874. The main sewers were originally ventilated only by the usual form of air grates in the centre of the streets, but owing to the steep gradients of many parts, this system was found very imperfect, so that as far as practicable they have been closed, and a system of large open shafts has been instituted, formed of concrete tubes two feet in diameter, built into brickwork carried up in every available situation. This plan has been adopted very extensively, and every opportunity that offers of adding to the number of shafts is carefully sought and utilized. The intercepting Sewer is almost entirely closed, but is most efficiently ventilated by means of the furnace constructed at Roedean, about one and a quarter miles from the Eastern boundary of Brighton. This furnace is kept burning continually, and is quite a unique and interesting feature of the sewerage system of Brighton. The cost of construction was £1,341 9s. 8d., and the cost of maintenance is £120 per annum. The members of The Sanitary

Institute will be invited to visit the furnace, and Mr. Lockwood will be prepared on the spot to give a more detailed description of its working, and other particulars connected with the Intercepting sewers than can be embraced within the limits of this paper.

As the Intercepting Sewer receives the whole of the sewage of the sister town of Hove, the expense of its construction and maintenance is shared between the towns of Hove and Brighton in properly adjusted proportions, under the management of a Joint Sewers Board, composed of ten members of the Hove Commissioners and twenty-eight members of the Town Council of Brighton. The average cost of maintenance is about £1400 per annum. A short time ago it was determined to extend the outfall at Portobello. Formerly the sewage was conducted seawards from the Intercepting Sewer by three 4 feet diameter wrought iron tubes, a length of 300 feet from the face of the cliff, but they have recently been extended a further distance of 730 feet, or 1030 feet from the face of the cliff. The contract price of this recent extension was £9,900. Thus the Corporation of Brighton is relieved from all anxiety or trouble on that much vexed question, "the disposal of town sewage," but the position has only been obtained by a bold and masterly grappling with the question—a spirit which seems to have been their guiding star in all their undertakings. The public sewerage system having been designed and laid down on the most scientific principles, and in all respects in such a way as to secure its thorough efficiency, this having been accomplished, the Corporation then turned its attention to another equally and perhaps in some respects more important part of the subject, viz., the inspection of the condition of the existing house connections, and those to be connected then and thereafter. For this purpose a Drainage Inspector was appointed under the direction of the Borough Engineer and Surveyor, with a competent staff, whose duty it is to inspect and correct all the details of house drainage, traps, ventilation, &c.; to see every pipe before it is covered, and when completed to test each drain, or branch of a drain, by the test known as the "water test." There is also an efficient staff of Sanitary Inspectors, under the control of the Medical Officer of Health. The system of house drainage, trapping, ventilation, &c., is shewn by the drawings which are exhibited, and by the model placed in the Health Exhibition held in connection with this Congress. It may briefly be explained as being designed so as effectually to cut off the house from the public sewer, to secure thorough self-cleansing water-tight drains, and perfect æration of the drains by inducing constant currents of fresh air through them. Thus

the air of the house is kept pure, and pollution of the soil under the house is quite prevented.

The cleanliness of the main sewers and their thorough efficiency is effectually secured by the regular system of flushing, which is carried on by means of plugging the sewers at the manholes, which are then filled with water to the extent of from 200 to 1500 gallons at each flush. This method is also shewn by diagrams on the walls, and a model in the Exhibition. A number of men are constantly engaged in this system of inspection and flushing, and the cost to the Corporation is not less than £500 per annum. The amount of water used per annum is from 18 to 20 million gallons, in addition to that used for household purposes, and the rainfall, which is not excluded from the sewers.

A most complete, but easily understood record of every drain inspected and tested, and of every public sewer flushed and repaired, is made daily. It is properly tabulated in a complete register, so that the information as to the condition of any house or sewer is readily available at all times for all purposes. A great deal more may be written on the value of all these sanitary arrangements, but I leave that to Dr. Ewart, a former Chairman of the Sanitary Committee, who has already treated of it most ably in a paper read upon the subject, from the medical practitioner's point of view.

The water supply of Brighton is now entirely in the hands of the Corporation, having been purchased in the year 1872 at a cost of £352,000. There have been important additions made to the scheme since that date, which have cost several thousands of pounds. I only allude to this undertaking in passing, as it is dealt with in a separate paper by Mr. Alderman Hallett, than whom no one is better qualified to give an account of it.

Another point in sanitation to which the Corporation has given great attention is the prompt and regular removal of house refuse. This is most efficiently done once a week by dividing the Borough into six divisions, and the employment of a regular staff of men and horses under the supervision of Inspectors. Special arrangements are made in the case of large establishments. The ashes are taken on to agricultural land outside the inhabited area of the Borough, and delivered free to the farmers, in addition to the payment to them of a small sum by way of rent for the use of their land as a tip; or they are taken to the ash yard at Hollingdean Road, on the Northern outskirts of the Borough, where they are sifted, and find a ready sale to brickmakers or farmers, being conveyed to any distance on the London, Brighton, and South Coast Railway, from the railway siding laid into the ash yard. The

system of collection and its supervision is very perfect, so that by a prompt and regular removal of house refuse, the air in the neighbourhood of dwellings is kept pure.

The butchers' "slaughter-houses" are licensed and put under strict supervision, so that the pollution of the air from this source is prevented.

The scavenging of the streets is also most carefully attended to.

In common with all old towns, Brighton has some places within its area occupied by the poorest class of its population, which, from the lapse of time and other circumstances, have become unsuitable or undesirable dwelling places. The Corporation has already taken in hand two of these large areas under the Artizans and Labourers Dwellings Act, so that an immense number of these old dwellings are to be demolished, and other suitable houses are to be erected for the use of those persons displaced by the improvement.

Having regard to the advantages of electricity over gas, from a sanitary point of view, in maintaining the greatest degree of purity of the atmospere within our dwellings, houses and shops, the Corporation has recently decided to erect an Electric Lighting Installation, with a view to supply the light at a price not in excess, by comparison, of that charged for gas. Power can also be supplied by the same system. The scheme has been prepared by James N. Shoolbred, Esq., C.E., and the cost estimated at £30,000. The usual Local Government Board enquiry has been held, and sanction given to the loan. Tenders for each section of the work have been obtained, and the total cost is within the estimate, so that it is expected that the work will be forthwith commenced, and the light will be soon extended to other portions of the town.

The Corporation has duly recognised the truth of the old adage, "Cleanliness is next to godliness," and its effect upon the health of the community. We have the sea as a bathing place for those who can afford time for the luxury; there are bathing institutions in the town for all who can afford the comfort of their appointment; but the Corporation has instituted establishments known as "Public Baths" for males and females, situate in the neighbourhoods where they are most convenient for the working classes, who have the privilege of obtaining a bath at the moderate charges of: First class—Hot, 6d.; cold, 3d. Second class—Hot, 2d.; cold, 1d.

The North Road Baths were opened in 1871, at a cost of £1,834; enlarged in 1874, at a cost of £4,034 with further additions in 1885, at a cost of £575. The Park Street Baths were opened in 1888, at a cost of £5,544. That these baths have been thoroughly appreciated by the people, and are a use-

ful factor in promoting the public health, may be fully realized by a reference to the following table of the number of bathers:—

1885 ... 68,169	1887 ... 76,236	1889 ... 98,824
1886 ... 72,790	1888 ... 92,426	

The formation of a suitable swimming bath at Park Street Baths, is under consideration at the present time.

With a view to render baths more attractive and useful, the Corporation have decided to try the experiment of a system of cottage baths dotted about in the poorest and more densely populated districts; this will have the effect of avoiding long walks to a central large bathing establishment. It will, indeed, be taking the baths to the people, and it is hoped will be a popular movement. The first institution of this kind is being constructed at the present time at Brunswick Place, North. Here a large house has been hired by the Corporation for a term of years, and is being fitted up with eight baths, four for men and four for women, supplied with both hot and cold water. The establishment will be under the care of a man and his wife, who will reside on the premises. From the interest already taken in the progress of the operations by the class of persons for whose use it is intended, there is every reason to believe the experiment will prove a success.

The Royal Pavilion, built by H.R.H. the Prince of Wales, afterwards King George IV., in 1784-7 as a royal residence, was purchased by the Corporation of Brighton in the year 1850 for about the sum of £60,000. In the years 1866-7-8 considerable improvements were made in the buildings at a cost of £7,310. The buildings and grounds are devoted to the public use. The rooms are being continually requisitioned for balls, concerts, and meetings of religious, scientific, benevolent, political, and other societies. The grounds are tastefully laid out, and form a most attractive and agreeable promenade and health-giving resort. The Dome is furnished with a splendid organ, and is often used for concerts and large public meetings. In 1871 a Free Reading Room and Reference Library, Museum and Picture Gallery, were established in the grounds adjoining the Dome at a cost of £7,402, and are a great acquisition for the health of the public mind. The buildings are lighted at night by an Electric Lighting Installation, erected by the Corporation on the estate in the year 1883 at a considerable cost, as the electric light was then in its infancy, and improvements have been made from time to time as a knowledge of the science has progressed. £5,046 stands as the capital sum expended up to the present date. In the year 1889 a magnificent Free Public Lending Library was opened and established

on the Pavilion estate, at a cost of £2,350 for books and fittings, in commemoration of the jubilee of the reign of Her Most Gracious Majesty Queen Victoria. The extent to which this is appreciated by the public will be understood by a perusal of the return of borrowers of books during the month of June, viz., 8645, and this shows a rapidly growing increase. The Corporation are now entering into arrangements for an additional building, to increase the accommodation so urgently required in this department.

Having given a brief description of the work already done, it will not be out of place, nor betray any official secrets, if I state that it is not the intention of the Corporation to remain satisfied with what has already been done; but, on the contrary, that there is a strong determination to progress in every direction, and to keep pace with the march of science in the interests of the public health. A public abattoir; a refuse destructor; a grand extension of the sea defences eastwards in the parish of Rottingdean, with suitable drives and promenade; a scheme for the better utilization of the Tenantry Downs; a yacht station opposite Kemp Town; various street improvements to relieve the congestion of some of the more crowded thoroughfares; and a new Town Hall, are matters which are already engaging the attention of the Corporation. Indeed the summing up of the whole matter cannot better be accomplished than by repeating the words which fell from the lips of the present Mayor of Brighton, on a public occasion, a few months ago:—"the very best of everything is not too good for Brighton," a sentiment which produced an audible and unanimous echo from the lungs of the large concourse then present. This shews how thoroughly and cordially the people trust, appreciate, and support the efforts of the "powers that be" for the common benefit of all classes of the community. Where this spirit and this principle predominates, the greatest and best achievements for good may be expected and accomplished. I hope, however, that I have submitted sufficient evidence to prove the assertion made at the commencement of this paper, viz., that the town of Brighton is by nature pre-eminently qualified to be called a health resort; that this has been fully recognised by successive generations of the inhabitants for the last 150 years; and that especially during the past 30 years the Corporation of Brighton has been most untiring in its exertions and wisely lavish in its expenditure, to secure to the borough the fame of being "the Queen of Watering Places." I venture now to go even further, and to prognosticate that from the public spirit which still pervades all classes of the community, and the grand schemes that have already been mooted for the further improvement of the

town, the time will shortly come when Brighton will be known far and wide by the imperial title of "Empress of Health Resorts," in addition to her present regal title of "Queen of Watering Places."

In concluding this paper, I acknowledge with gratitude the willing and generous help accorded me by each of the official heads of the various sections of the department of which I now have the honour to be chief, and other friends. As I have only held my appointment about eight months, it would have been impossible for me to have submitted to you the facts recorded in this paper without their assistance. My predecessor, Mr. Lockwood, will kindly take my place in the discussion that may ensue, and will give any further information that may be required.

Drainage.

Public Sewage Works	£120,000
Intercepting Sewer.....	104,608
Roedean Furnace Ventilating Shaft.....	1,341
Ventilating Shaft and Flushing Chamber at Rottingdean	1,126
	£227,075

This does not include the cost of extending the outfall pipes at Portobello, the contract for which was £9,900, as the work is not yet completed.

Population, Length of Highways, Sewers, &c.

Year.	Population.	Highways.	Sewers.	No. of Houses.
		Miles.	Miles.	
1861	77,693	55	11	13,307
1875	99,374	64½	53½	15,776 (1871)
1890	123,659	85¾	72¼	18,668 (1881)

Some items of Brighton Expenditure, 1859—90.

	Cost of Works executed by Boro' Engineer.	Improvements on Sea Front.	Groynes.	Preston Park.	Baths.	Water Works (exclusive of laying mains, &c.)	Royal Pavilion Improvement (exclusive of cost of redecorating rooms	Drainage	Sanatorium.	
	£	£	£	£	£	£	£	£	£	
1859	24,357									
1860	24,619	.....	400							
1861	36,411	.....	400							
1862	27,573	.....	2785							
1863	25,440	.....	400							
1864	34,176	4813	4760							
1865	52,926	4813	6591							
1866	62,665	1778	5583	.....	.....	.....	3150			
1867	65,442	1778	400	.....	.....	.....	3150			
1868	63,631	.....	4258	.....	.....	.....	1010			
1869	73,696	.....	2531							
1870	61,407	.....	400							
1871	65,523	1148	400	.....	1834	.....	7402			
1872	63,619	1004	2336	.....	.....	352,000				
1873	42,305	.....	1168							
1874	46,437	.....	1420	.....	4034					
1875	55,836	.....	637	.....	575					
1876	46,546	.....	4080							
1877	57,811	.....	12179							
1878	53,334	.....	1869							
1879	57,537	.....	1108							
1880	58,222	6452	400	.....	.....	1165		Total £227,075		
1881	64,461	1650	809	.....	.....	.....	.....	.....	4470	
1882	73,439	1428	400	55000	.....	1706	.....	.....	3320	
1883	76,580	6399	1390	2492	.....	319	2705			
1884	92,742	.....	3884	2491	.....	1024	2906	.....	1114	
1885	70,047	.....	4237	2878						
1886	68,324	.....	4098							
1887	78,537	.....	400	594	.....	.....	161			
1888	71,737	25466	6405	1588	5544	.....	.....	.....	994	
1889	.....	1297	400	.....	.....	.....	115			
1890	.....	16415	.....	.....	276	.....	590	.....	1811	£342,784 Total.
	*	74,000	76,000	65,000	12,000	356,000	21,000	227,075	11,709	

* The Total, 1859—1888, was £1,675,580.

Professor T. Roger Smith (London) first remarked that Mr. May's paper afforded such a comprehensive and interesting statement as to make one admire the untiring energy of the Brighton Corporation in matters both of sanitation and improvement.

Mr. C. H. Cooper (Wimbledon) thought Mr. May should have

directed more of his remarks to the health of Brighton. There was a list published, he did not understand by whom, showing that Brighton's death-rate was the lowest of the towns with which it was compared. Singularly enough, however, that list contained no mention of such acknowledged health resorts as Hastings, Scarborough, Eastbourne, Weymouth, Bournemouth, Torquay, Ramsgate, Ilfracombe, &c., and he thought this omission was somewhat unfair, especially as in many of these places the death-rates were very low indeed.

Mr. BALDWIN LATHAM (London) asked what amount of leakage there was into the outfall sewer? It seemed to him that it was very extraordinary that instead of increasing the number of their outfall sewers the Brighton authorities, finding greater demands upon them, had extended their length, a proceeding which he held must certainly diminish the effect of their discharging capacity. The effect of this lengthening was simply this, that whilst the present sewers were ample for all purposes of conveying away the sewage of Brighton when the rain fell the overflow that took place of sewage and salt water must be enormously increased. He wanted to know therefore how many hours at neap tide the interior of the sewer was absolutely free, and also what steps were taken for cleansing it? With regard to the question raised by Mr. Cooper, he understood that the list of towns with which Brighton's mortality was compared in the manner he had named was framed by the Registrar-General. It was true it did not mention all the large towns, but they were such towns as were large when the returns were first made, and owing to the difficulty of making alterations, other towns entitled to be mentioned on the list had failed to get their request to be placed on it acceded to. So far as Brighton was concerned, the death-rate given in these returns was not reliable, for the town's population had been over-estimated. In reality this rate was slightly higher than that generally believed, a conclusion which he had arrived at by estimating the population after the method which he brought before the Medical Congress a few years ago. This method was to divide the births by the deaths since the last census and add the remainder to the population at that period. When the next census was taken Brighton would find that its population had increased in only a very small degree. With regard to the general character of the works which had been executed in Brighton he was of opinion that they had been exceedingly well done, though with reference to the sanitary arrangements of the town, he had to bear out the remarks of previous speakers that they were not always perfect. For example, he was staying at an hotel where the old pan closets were used. Anything more disgusting than these he could not conceive, nor could he conceive how any person could tolerate such disgraceful sanitary appliances. House drainage too was done in many towns in a manner more simple than in Brighton. He was sure that Brighton people would only thank them for drawing attention to these matters. He hoped when next they wanted sanitary works carried out they would not go, as they had done previously, to a railway engineer.

Mr. MAY (Brighton), being called upon to reply, said that the remarks which had been made would be borne well in mind after the Institute had left the town. He unfortunately found himself in a very difficult position with reference to the questions which had been asked and had not already been answered, for he had only been surveyor of Brighton a very few months, and the ex-surveyor, Mr. Lockwood, who was to have been present to answer any points which might be raised in the discussion was too unwell to be in attendance. Brighton was so large a town that he had not yet had the time to get all its details at his fingers' ends; and so far as the outfall sewer was concerned that was beyond his province, for Mr. Lockwood, who had commenced the work had been retained by the Sewers Board to see the completion of its extension. Under these circumstances, which he felt sure the section would quite understand and respect, he was unable to answer the question which had been raised, and he could only hope that opportunity would be afforded by a personal visit to the sewer for the members of the Congress to get an explanation of these things of which he had not personally the knowledge to make clear to them. With reference to the condition of Brighton from what he might call a medical officer's point of view, such as its birth-rate and death-rate, he had purposely refrained from entering upon these topics because they had been or were to be dealt with by papers prepared for the Congress by Dr. Newsholme, Dr. Ewart, and Dr. Turton. He did not of course wish his paper to overlap theirs, and he thought that all Mr. Cooper wanted to know would be found in the papers which those gentlemen had taken the trouble to prepare.

On "The Necessity for Improvements in the Sanitary Arrangements of Dairy-Farms, and for their more Careful Inspection by Sanitary Authorities," by WALTER HEPWORTH COLLINS, F.C.S., F.R.M.S., &c., Member of the Society of Public Analysts; Consulting Chemist and Gas Examiner under the Gas Works Clauses Acts for the Local Board Districts of Pemberton, Kersley, &c.; Analyst and Gas Examiner to the Bolton Corporation Gas Works, the Ashton-under-Lyne Gas Company, &c.

THE absolute necessity of a good supply of suitable water to farms, and dairy-farms in particular, is eminently obvious; and as a general rule, farms anywhere near a large town are perfectly safe in this respect. Those farming establishments,

however, situated some considerable distance in the country, have to depend on their water supply from ponds, springs, brooks, and wells; and in these cases the water is used for both domestic and cattle purposes, cleansing, and all ordinary household operations, without as a general rule any attempt or apparent effort at purification. Many of these farms send daily by rail all their milk, butter, and cream to large populous centres; and as such farms are the principal sources of supply of these "necessary comestibles," it is essential that their sanitary conditions and surroundings should be of the most perfect character in the interests of the public in general, and the regular milk consumer in particular.

It has been repeatedly shown that milk is one of the best "carriers" we have of micro-organisms or disease germs of a malignant as well as a beneficent character; consequently it behoves all sanitary authorities and their officials to exercise the utmost care in the inspection and supervision of dairy premises, and in the judicious enforcement of the law relating to and regulating such premises, as well as the retail milk-shops.

It is apparent that much danger can arise from these places—a danger that would undoubtedly influence the death-rate of our large towns; and the typical country farm, with its slovenly constructed premises—although probably most picturesque—and its absolutely unsanitary accessories, is indeed suggestive of a source of unlimited danger to public health. The drainage is, as a rule, unconfined and exposed, and generally gathered together into a small pond in the farm yard, from which the cattle are permitted to drink. The shippons and cow-houses are exceedingly badly drained and worse ventilated, and the air of the shippon simply teems with micro-organisms of a more or less malignant character.

I recently had occasion to inspect and investigate the sanitary condition of an extensive dairy, from which immense quantities of milk are sent daily into one of the largest cities in the kingdom. Dealing with the water first, I found that their only supply was from a spring rising in a field, a considerable distance away, and which field had lately been manured with offal and other slaughter-house matter! The drainage from this field ran direct into the water-course from the spring, and this water was then used without any attempt at filtration, settlement, or any other treatment whatever, for all domestic, dairy, and farm purposes.

An exhaustive microscopical examination of the water showed numerous diatoms, desmids, algæ, and infusoria belonging to the paramecia. A bacteriological examination of the water was then made by the gelatine process referred to by my friend

Dr. Percy F. Frankland, in the Transactions of the Sanitary Institute Congress, 1887, and the sample selected, after being passed through an ordinary domestic carbon filter, yielded 3,600 micro-organisms per cubic centimetre.

A portion of the same sample gave the following results on analysis:—

Total Solids (grains per gall.)	39·36	
Organic Carbon	1·921	per 100,000
Organic Nitrogen	1·036	„
Ammonia	1·104	„
Chlorine	11·569	„

This water had been regularly used for years; but the household had experienced almost periodic attacks of fever of a low description.

The pond water in the farm yard was highly polluted by shippon, stable and house (dairy slops) drainage, and also sewage from the house itself; but the cattle drank, in passing, from this pond with absolute avidity! I was, however, informed that they suffered from regular attacks in summer weather of diarrhœa, the cause of which could not be accounted for.

The air of the shippon, or cow house, was found to yield on examination the following:—

Mean of Twelve observations.

Carbonic Acid	17·3	per 10,000 vols.
Organic matter	69·96	per cent.
Bacteria	209	per cubic centimetre.
Moulds	315	per cubic centimetre.
Total Micro-organisms	524	per cubic centimetre.

The shippon was a long low building with small ventilating holes near the roof, the floor being paved with bricks; the drainage ran along an open gutter in this floor, along the length of the building and out through a small hole in the bottom of the wall, across the farmyard, and into the pond above referred to. Fresh air was admitted through three large holes cut through the door at the bottom, and also by a small flap-door window. The samples of air were all taken during the time the animals were being milked.

The air of the dairy house where the milk was cooled, churned &c., and the cans made up, cleaned, and washed, was examined with the following results:—

Mean of Nine observations.

Organic matter	40·16	per cent.
Bacteria	115	per cubic centimetre.
Moulds	96	per cubic centimetre.
Total Micro-organisms	211	per cubic centimetre.

A dilute solution of "crude carbolic acid," of the strength of one ounce acid to one gallon of water, was used in the dairy for

washing the floors, benches and shelves. A sample of this solution in use was carefully examined, and found to contain 1,296 micro-organisms per cubic centimetre.

It is therefore most important that public attention should be called to the unsanitary state of those diary farms of which I have given a type. I am acquainted with many milk producing establishments whose surroundings and general sanitary conditions are really no better than that already referred to; the milk, cream, butter and other produce of such places, are all more or less liable to become tainted and infected by their foul surroundings, and thus become the medium for conveying to the human system organic matter and micro-organisms of the character previously shown; and a great, and sometimes mysterious danger to public health caused thereby.

On "The Iron Process, as applied to the Disinfection of Sewage in Barracks and Dwelling Houses," by Major CONDER, R.E.

ABSTRACT.

Invention by the late F. R. Conder, M.Inst.C.E., of a Self-regulating Chemical process for application to closed drains on various scales.

The proportional dosing of the sewage with iron in solution thus rendered practical at small cost. The result is the disorganization of the sewage into inorganic elements, producing a silt easily dried, and a pure effluent within requirements of Rivers Pollution Committee. The offensive odours destroyed and the bacterial germs killed, as shown by Government analysis.

House application, by an instrument called the "Ferrometer," intended for about ten people, and requiring to be filled and cleared once a month. This has been applied at Windsor Castle, Buckingham Palace, at various houses of the Marquess of Bute, and by the Duke of Wellington, Lord Salisbury, Lord Lorne, and in some 300 cases in country houses to the satisfaction of those who have adopted it.

Drain application.—At present the process is only working in England on a small scale. It was adopted at Chichester barracks by the War Office, in 1886, and paid for under

agreement that it should first be reported satisfactory by the commanding engineer. The number of persons treated is about 1000.

It was further adopted by the Admiralty at Eastney Barracks, Portsmouth, in 1889, and after six months' trial has been reported successful, and negociations commenced for applying it to 2000 persons. The Admiralty analyst reports the destruction of bacterial germs in the treated samples.

On the property of the Duke of Northumberland at Alnwick, it has been applied to the Castle and to 1500 persons on the property, and reported by the Clerk of the Works to be the best process with which he is acquainted.

At Grange-over-Sands in Lancashire, it was applied in 1889 to 300 persons, and the results found satisfactory. The Inspector of the Local Government Board having given a favourable report, the Local Board of Health was empowered to raise money for the development of the drainage system; and this having been carried out, the process is now being applied to the new drains, and has been reported successful.

In these cases the form of instrument consists of tanks and cones placed in pits by the drains, but the principle is the same as that of the household instrument.

Further applications on a larger scale are now commencing at Halifax in Yorkshire, and at Toronto and other places in Canada.

The advantages claimed for the process are—

1. That it can be applied immediately, without alteration of existing drains.
2. That it destroys the sewer gases from the point of application, and not merely at the outfall.
3. That the effluent may be discharged direct into any stream without injury to the water.
4. That the expense is very small and the application simple to maintain.
5. That the silt is inoffensive and has been shown to make a good manure.

The success of the method depends on the proper apportionment and correct position of the apparatus, and on the saving of labour due to the automatic action which secures a constant application. The difficulty hitherto found in dealing with a bulky and offensive sludge is thus overcome.

Dr. A. CARPENTER (Croydon) rose to give a most emphatic denial to Major Conder's statements with regard to sewage farms. His

experience of sewage farms, extending over thirty years, was that as they applied the sewage so must they take off such an amount of soil water as would correspond with the amount of sewage applied. With regard to the use of iron he had found it not only very expensive, but the mischief resulting to the streams below was such as compelled them to give it up. Under certain circumstances no doubt there was nothing more efficient than the use of sulphate of iron, but the principle was one which ought not to be adopted with regard to the country at large. It was injurious to the interests of the country that the material that was contained in human sewage should be destroyed; such sewage should on the contrary be conveyed immediately to the soil set apart for its treatment, and then there could be no mischief resulting from its application. With regard to the question of open sewers he thought there was a minimum amount of danger with the maximum amount of fear. The fear was wholly with the public, but from an experience of thirty years he was satisfied that the mischief was of a very minor character, and it was far better he held even that some effluvium should escape through an open sewer than that there should be gases confined in the sewers themselves. He contended moreover that sewer gas was a misnomer, for in sewers properly constructed and washed out no such gas could ever exist. If they got the sewage on to the land prepared for its reception within three hours from its discharge there was no risk, for before the time arrived for it to do any damage the mischief was removed by the agency of the beneficent microbes. They dealt effectually with all injurious matter, and deprived it of its sting. To adopt any system that would do away with the influence of these beneficent microbes would be ten times more injurious than to get rid of these microbes, and it would be contrary moreover to the best interests of economy.

Mr. Woodruff (Brighton) thought we were somewhat backward in the disposal of sewage so far as country districts were concerned, and he considered Major Conder's suggestions were very applicable to such districts, and more especially in those of them where cesspools were continually overflowing. With regard to sewer ventilators, he presumed that Major Conder referred to street ventilators; he himself had had considerable experience in these matters, and in Brighton, he might tell them, they were working on the principle of closing up these ventilators and substituting for them ventilators at the tops of houses. In many cases they built large shafts at the rear of houses, whilst in others pipes were put up in front. With regard to sewage farms, he had recently been journeying in Germany and other parts of the Continent, and he believed he had visited all the sewage farms in those parts, and from his experience he considered Mr. Conder's opposition to sewage farms was wrongly based. What he called the desideratum of a sewage farm was sandy soil. Of course, he found that it depended a great deal on the position and locality, and all special conditions had to be dealt with in a special manner. Sewage

farms, he thought, ought to be considered on their merits and not condemned in the wholesale manner adopted by Major Conder.

Mr. William White (London) observed that all those who had heard Dr. Poore's address to the Sanitary Science Section of the Congress would fully agree with what Dr. Carpenter had said with reference to the false principle and false practice of eliminating microbes from sewage. They ought, on the contrary, to be made use of in the cultivation of the land. Though he could not pretend to treat in detail of sewage farms, he should like to say that clay was unsuitable for such farms, whilst sand, which had been spoken of as a good medium, was, in his opinion, the very worst. He thought too that Mr. Moule had made a great mistake in the principle he had adopted of mixing with the soil sand, ashes, and baked clay. The earthworm could not be cultivated in these materials, and in connection with sewage the earthworm as they knew was most valuable. He had seen Mr. Moule's process at Dorchester, and at his shed where the soil was absorbed there was emitted anything but a sweet odour, and if it had been within the limits of the town it would no doubt have been amenable to the sanitary authorities. As regarded the ventilation of sewers there was no generation of sewer gases in properly ventilated sewers. This suggested the question whether sewers could not be so constructed as to carry off their contents to certain pumping stations within a convenient distance of the town in order that the sewage might be made use of in a fresh state. In villages there should not be the same difficulties of disposing of sewage as in towns, for there it was competent to spread the sewage over the land. With regard to the ventilation of sewers in the street, the system of carrying the pipes up the houses mentioned by Mr. Woodruff appeared in the first instance to be satisfactory, but to carry away the whole of the effluvium they must adopt separate systems to ensure ventilation, because each pipe that ventilated near the lower part would take the current away from the upper part and it therefore appeared that the system brought under their notice by Mr. Woodruff was insufficient.

Sir Thomas Crawford (London) said that he had had some considerable experience of the ventilation of sewers, and he held that the great object of ventilating sewers was not to let out gases but to let in fresh air. The moment the ventilators in streets became offensive that moment they had an absolute proof that the sewer was not sufficiently perfect for its purpose. Their object then should be not to close but to keep open the ventilators, in order, amongst other advantages, that they could detect any effluvium that might exist. He quite agreed with all that had been said during the discussion on removing sewage to the soil. The great difficulty in this connection was in dealing with old towns, but the great principle everyone he thought could bear in mind, and that was to give in the disposal of sewer gases an absolute free current of fresh air.

Mr. H. H. Collins (London) rose to corroborate the remarks of the President of the Congress, and also drew attention to the danger of preventing the access of free air to ventilators. To him it seemed that to advocate the system of carrying up pipes to ventilate sewers was a confession that the sewers were defective. There had been some attempts to introduce this system into London, but it had been found very difficult to get permission to run the pipes up houses, and he did not think the system was ever likely to be firmly adopted either in London or the suburbs. Let the sewers remain open, and let them get a current of air to pass through them as frequently as possible; and as time went on the public at large would have less fear and more common sense, for keeping them open was undoubtedly the best means of keeping the sewers sweet. When there was a complaint about any sewer being offensive, they knew there was something the matter with that sewer; and knowing that, they knew also how to deal with the defect. So far as country houses were concerned, Major Conder's remarks would no doubt prove useful.

Colonel Jones (Carshalton), speaking from twenty-five years' experience, was able to endorse the remarks which had been made. The question of ventilating sewers was a very important one, and he did not hesitate to say that the notion that they could get rid of bad smells by carrying them up into the air was radically wrong. Far better was it that smells should remain on the surface, for then steps could be taken to set defects right.

Professor Roger Smith (London), the President of the Section, reminded them, with regard to this question of sewage, that they had an enormous number of old districts to deal with, and the difficulties in the way of establishing sewage farms in these places was very great. Indeed, many local authorities would not countenance them at all. They might therefore welcome any means of bringing about a better state of affairs than now existed, even if those means were not the best that could be employed.

Major Conder (Southampton), in reply, said that he belonged to an army corps which had had considerable experience in draining its barracks; and without wishing to express any opinion contrary to that of the professional scientific men who had been good enough to discuss his paper, he must say that it was always considered to be extremely unhealthy for any collection of soldiers to have a drain effluvium in the neighbourhood of their barracks. But apart from any dangers to health, odours in the street were very offensive to the inhabitants, who would hardly stop to enquire their possible advantages before doing everything in their power to get rid of them.

On "The Disposal of the Sewage of London upon the Maplin Sands," by Richard F. Grantham, M.Inst.C.E.

The great difficulty in dealing with the sewage of London is its enormous volume, nor is there any precedent for dealing with the sewage of a city with a population of several millions, increasing at the rate of more than 70,000 per annum.

In considering the methods for disposing of London sewage, we must be guided rather by the particular circumstances than by the methods which have been actually tried in smaller towns.

The quantity to be dealt with and the extent to which the present known methods are applicable, having regard to the fact that it is practicable to discharge the effluent into a tidal estuary, are the first questions which arise in the consideration of the subject.

The Royal Commissioners in their first Report on Metropolitan Sewage Discharge stated, that the average daily quantity for a few past years had been at the rate of 19,000 cubic ft. per minute. This is equivalent to a river 40 ft. wide at its water surface, 5 ft. deep, flowing continually at the rate of about 2 ft. per second. It is estimated also that in that quantity, there would be about 4,500 tons per diem of wet sludge, and about 900 tons per diem of pressed sludge in cakes. Finally, in order to prevent further pollution of the River Thames, the Commissioners recommended that some process of deposition or precipitation should be used to separate the solid from the liquid portions of the sewage, and that the solid matter deposited as sludge should be applied to the raising of low lying lands, or be burnt or be dug into land, or be carried away to sea.

The liquid so separated would not however, they thought, be sufficiently purified for its discharge at the present outfalls to be adopted as a permanent method of getting rid of it, and its further purification could only be effected by its application to land by means of intermittent filtration. They thought also that sufficient land of a quality suitable for this purpose existed within a convenient distance of the Northern outfall, and the liquid they suggested could be pumped up on to this land from the separating works, and after filtration allowed to flow into the river.

If, however, sufficient suitable land at reasonable cost could not be procured near the present outfall, they recommended that the separated liquid be carried down to a lower point of the river, at least as low as Hole Haven, where it could be discharged,

the liquid from the Southern outfall being taken across the river and the whole conveyed down the Northern side.

As a step towards the fulfilment of the first part of the Commissioners' recommendations, the London County Council has completed the construction of large precipitating tanks at the outfall on the North side of the river, and is building similar tanks on the South side, for the purpose of treating the sewage with certain chemicals, viz: lime and sulphate of iron in the proportions of 3·7 grains per gallon of the former, and 1 grain of the latter, to each gallon of sewage, and if necessary ½ to 1½ grains, or even 3 grains, of permanganate of soda to be added to each gallon of the effluent. But the Commissioners observed that in any precipitation process the liquid could only be allowed to escape into the river as a preliminary and temporary measure, while several eminent authorities, Sir Robert Rawlinson, Sir Henry Roscoe, Dr. Corfield, Mr. Baldwin Latham, Mr. J. C. Mellis, and Dr. Tidy, have pronounced these proportions insufficient for the purpose of effecting any appreciable degree of purification of the sewage.

In accordance with part of the recommendations the solid matter deposited as sludge was to be carried out to sea, and the London County Council give effect to this by conveying it thither ultimately at the rate of about 18,000 tons per week.

It will have been observed that under this system there are three things to be kept in view.

1. Treatment of the crude sewage by chemicals.
2. Disposal of the sludge.
3. The distribution of the effluent on land or its discharge into the river at Hole Haven.

Other schemes have been suggested, such as irrigation without any chemical treatment, deposition and filtration on Canvey Island, and lastly, the conveyance of the crude sewage to the North sea in a canal open for part of its length.

Seeing that so many authorities have agreed in condemning chemical treatment as insufficient of itself to effect the proper degree of purification, let us consider the further treatment recommended.

It is important, first of all, to ascertain what quantity of land is necessary for the absorption of so large a volume as 180,000,000 gallons per 24 hours—approximately the normal quantity of sewage, without allowing for increase or storm-water. The only area suitable near the northern outfall is a tract of land, the subsoil of which consists of gravel, lying between the Great Eastern Railway and the London, Tilbury, and Southend Railway, its eastern boundary being approximately defined by a line drawn through Romford, Upminster, Ockenden, and

Purfleet. But since the publication of the Commissioners' Report (1884), a new line of railway from Barking to Pitsea has been made between these two lines, enhancing the prospective value of that tract of land. The subsoil of the marshes adjoining the river consists of alluvium, and therefore they are not suitable for the absorption of so large a volume of liquid. The estimates of the number of persons whose sewage could be applied to each acre of irrigation or filtering ground have varied from 100 to 3,000, but the latter figure has been reduced by Mr. Bailey Denton, in order to secure permanency of effect, to 1,000. These figures, however, if adopted without reference to the soil of the land upon which the sewage is applied, and without reference to times and seasons, would be misleading, and are not borne out by the everyday experience of actual practice. The practical application of sewage, as illustrated by the following list taken from official and other reports, differs from these estimates, and it will be seen that even in cases of intermittent filtration, combined, as it mostly is, with broad irrigation, the sewage of 1,000 persons, taken at the ordinary calculation of 30 gallons per head per diem, is in excess of what has actually been applied for any length of time when the growth of crops is necessarily taken into consideration.

Name of Place.	Quantity of Sewage per 24 hours.	Gallons of Sewage applied per acre per day.	Soil.
Edinburgh	2,500,000	10,000	Subsoil, sea-sand.
Banbury	320,000	2,300	Stiff loam upon clay subsoil.
Bedford	700,000	4,516	Rich loam with gravelly subsoil.
Blackburn	1,500,000	16,000	Light loamy soil upon gravelly subsoil.
Chorley	500,000	5,747	Poor vegetable soil with stiff clay subsoil.
Doncaster	600,000	5,217	Light sandy land.
Leamington	800,000	2,950	Fine loam on subsoil of gravel.
Merthyr Tydfil.....	1,000,000	13,333	Fine loamy soil with gravelly subsoil.
Rugby	400,000	6,153	Gravelly soil upon clay subsoil.
Tunbridge Wells...	650,000	3,000	Stiff loamy and light open.
Warwick	700,000	5,185	Stiff clay.
West Derby	723,000	3,500	
Romford (Breton's Farm) ...	.....	1872–73—2438	Loamy gravel and sand.
	.....	1874–75—2453	
	.....	1875–76—2782	
Slough	.....	3,047	Sharp gravel and sand.
Barnsley	700,000	16,886	Subsoil of loam.
Aldershot	156,800	1,960	Poor sand.
Croydon	3,000,000	11,540	Open soil upon gravelly subsoil.
Berlin (Osdorf & Heinersdorf) ...	863,132	3,116	Sandy soil.

The same Commissioners, after referring to the case of Kendal, remark, that "for a small number of people, say under 500 to the acre, the sewage may be applied as it comes, leaving the grosser matters to become amalgamated with the soil, but if the number be increased, the previous removal of the sludge would be desirable, and for 1,000 or more it would probably become absolutely necessary."

It cannot be shown by any process of filtration or irrigation, omitting the case of Kendal as exceptional, that a greater quantity than 16,000 or 17,000 gallons per acre (equivalent to rather more than an addition of ¾ in. every 24 hours to the rainfall) can be distributed on ordinary agricultural land without interfering with its proper cultivation.

It would not be safe then to provide a smaller area of ordinary land than 10,000 acres, and this does not include any large increase in the future.

The cost of the land and its preparation in the cases of Abingdon and Malvern as described by Mr. Bailey Denton in his work, "Ten years' Experience of Intermittent Downward Filtration," amounted to £286 per acre in the case of Hitchin, to £251 per acre in the case of Abingdon, and £225 in the case of Halstead. Probably, therefore, the cost of land and its preparation for the treatment of London sewage would not be less than £300 per acre, or £3,000,000 for the 10,000 acres. Besides this there would of course be the cost of conduits from the Northern and Southern outfalls, and the cost of pumping power to a minimum height of say 75 ft. above Ordnance Datum, without any allowance for increase.

Assuming that the population continues to increase at a similar or possibly even at a greater ratio than has been stated, and assuming the correctness of the above estimates, what provision can be made for future extension of the irrigation or filtration area? Nearly the whole of the gravel bed described having been utilised, the subsoil of clay of which the surrounding country partly consists, not being able to absorb liquid at the same rate, proportionately larger areas must be acquired. But it may well be doubted whether it would be expedient to devote so large an area of land in such a district to the perpetuation of what is regarded by many, rightly or wrongly, as a nuisance, and which certainly would be looked upon as detrimental to the value of the surrounding property.

Considering the strong consensus of opinion against the proposed chemical treatment, and, indeed, against any chemical treatment of the sewage, and in view of the difficulties already pointed out attending its disposal upon land, there would appear to be only two courses open: either that the liquid should be discharged at Hole Haven, or that it should be dealt with on the Maplin Sands.

But if the system now being tried should not sufficiently purify the sewage, the nuisance hitherto complained of will be as offensive to Southend and other places as it is higher up the river. No advantage will have been gained by discharging the effluent into the river at Hole Haven, and the County Council will be compelled either to increase the proportions of the chemicals with which the sewage is to be treated, or to remove the outfall still further.

Now it is claimed, on behalf of the scheme for the deposition and filtration of sewage on the Maplin Sands, that that spot would afford all the advantages claimed for Canvey Island, together with the advantage of being much larger in extent and removed far away from Southend or any watering place. Further; instead of a fertile tract of land being rendered valueless for agricultural purposes, a piece of land would actually be added which, as will presently be shown, may be made exceedingly fertile and valuable.

The general line of outfall is somewhat similar to that proposed, in 1857, by Messrs. McClean & Stileman, and lately revived by Sir Robert Rawlinson; but it differs from the latter in some important details. The chief of these are:—

1. The conduit to the Sands would be covered all the way, and would have a uniform fall throughout.

2. While the whole volume of the sewage would be dealt with on the sands when reclaimed, the method of treatment would be so designed as to remove all ground of opposition on the part of those who are interested in the oyster fisheries of those coasts.

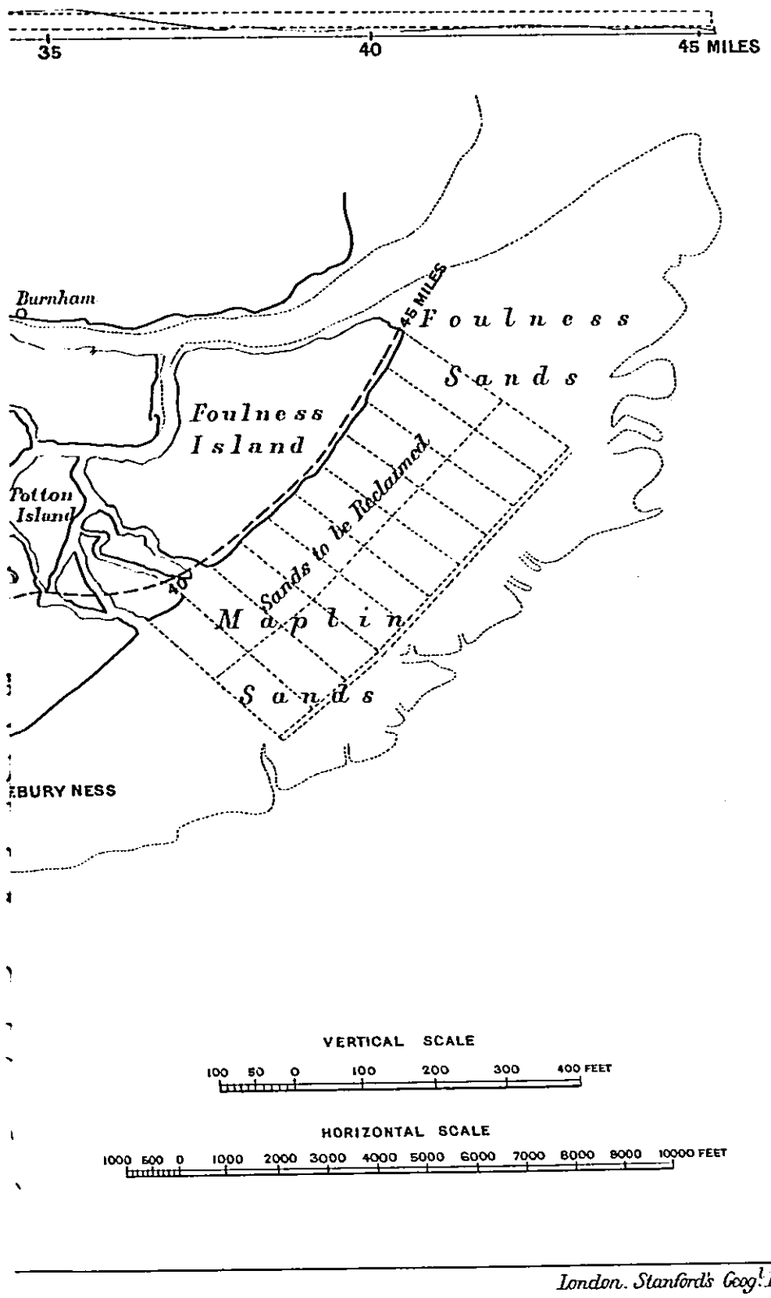
Commencing at the outfalls, it is proposed to establish additional pumping power at the northern outfall to the extent of about 1100 h.p., and to pump the sewage up to an aqueduct, comprising two culverts 15 feet each in diameter, the inverts of which would be laid at a level of 27 feet above Ordnance Datum at the outfall, and be carried with a fall of 9 inches per mile for a distance of about two miles, where a junction would be made with the sewer from the southern outfall. At the southern outfall, additional pumping power to the extent of about 1050 h.p. would be provided, and the sewage would be pumped through a syphon 9 ft. 6 ins. in diameter under the river to an aqueduct consisting of a culvert 15 ft. in diameter, commencing on the north side of the river opposite Crossness, and extending to a junction with the aqueduct conveying the sewage from the northern outfall.

From this junction the aqueduct would convey the sewage

from both sides of the river a distance of about two miles in three culverts, each 15 ft. in diameter, to the upper end of the new outfall sewer, between Dagenham and Rainham villages. From this point the new outfall sewer would convey the sewage to the Maplin Sands along the line shown on the annexed plan.

The sewer which would be of concrete lined with two $4\frac{1}{2}$ in. rings of blue bricks would be 25 ft. in diameter, and would have a fall of 6 in. per mile without a vertical bend or syphon in the whole distance, the level of the invert at the lower end to be 4 ft. above Ordnance Datum. The line has been laid out to follow the contour of the land, so that as far as possible the culvert will be wholly underground, but at no greater depth than will afford a covering to the crown of the arch with the least possible embanking and tunnelling. The discharging capacity of the culvert when half full would be equal to 33,747 cubic ft. per minute, the velocity 2·3 ft. per second. At Foulness Island the conduit would be built parallel to and behind the whole length of the front sea wall with sluices in it at various points to admit of the discharge of the sewage on to the several plots of reclaimed land. It has already been shown that an area of less than 10,000 acres of ordinary agricultural land would not be sufficient for the treatment of the sewage, and although the soil of the area proposed to be reclaimed differs altogether from the soil inland, it would not be desirable to enclose less than 10,000 acres of it. It is proposed, then, to raise embankments, formed of clay from the line of the outfall sewer and sand from the foreshore, and to enclose the Sands in plots of 500 acres at a time. 4,750,000 cubic yards of material it is estimated would be dug out in the line of the proposed conduit, while there would not be more than about 2,000,000 cubic yards required for making the embankments, assuming that they were made ten feet wide at the top and raised to a level of eighteen feet above Ordnance Datum. About 1,750,000 cubic yards would be required for the concrete in the construction of the conduit, and it is expected that this would be found in the excavation. The material for the embankments could be economically transported from the spot where it would be dug to its destination in trucks running on lines of rails laid within the conduit itself as the construction proceeds, the diameter being sufficient to admit of a line of rails each way, up and down. On the verge of the sea frontage of the newly-reclaimed land a channel for the effluent water would be built, whence the effluent would be discharged through various outlets into the deep Swin Channel.

To determine how the reclaimed area should be best laid out for the treatment of the sewage, it must be shown what might be its exact capacity for absorbing and purifying sewage.



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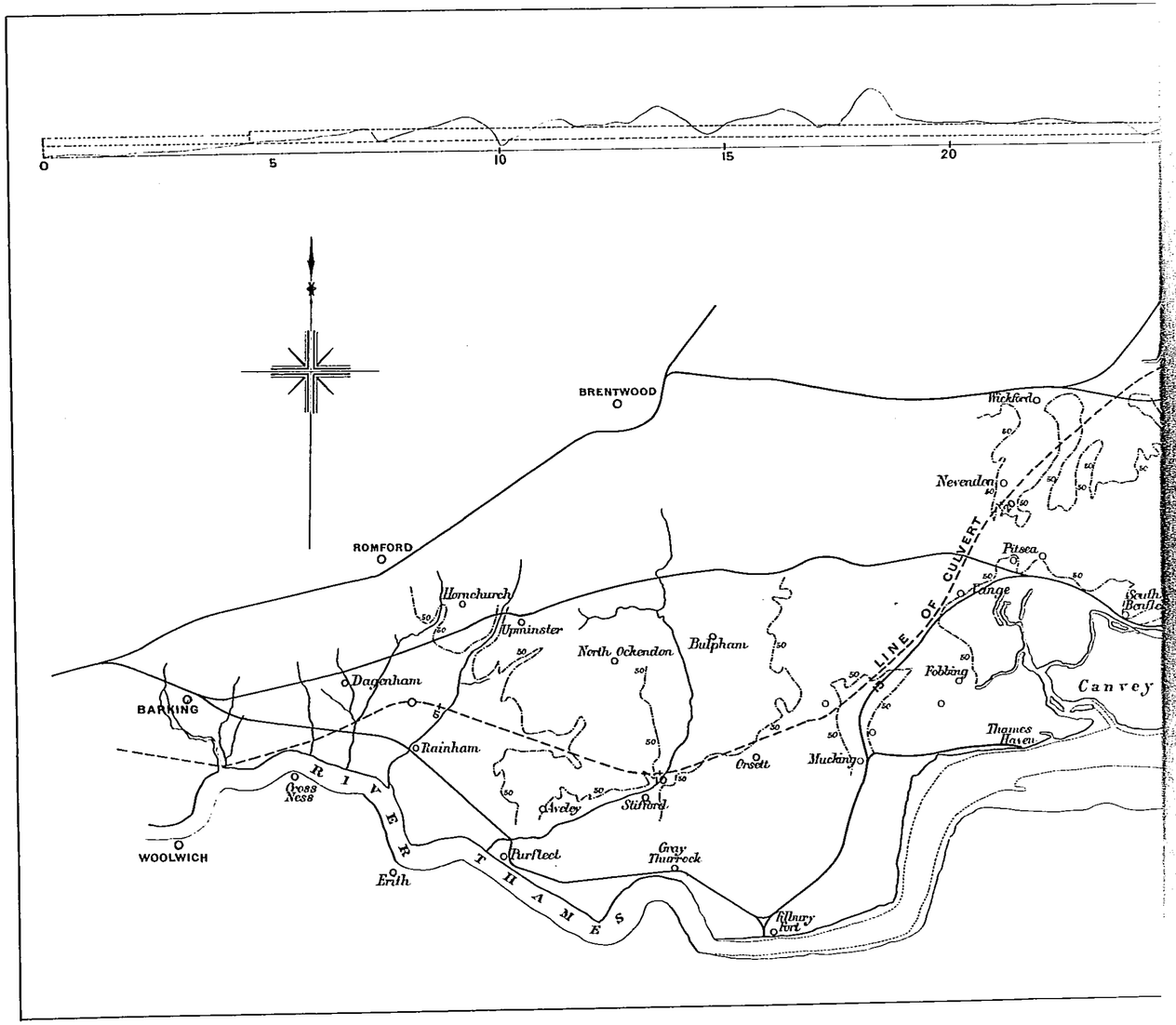
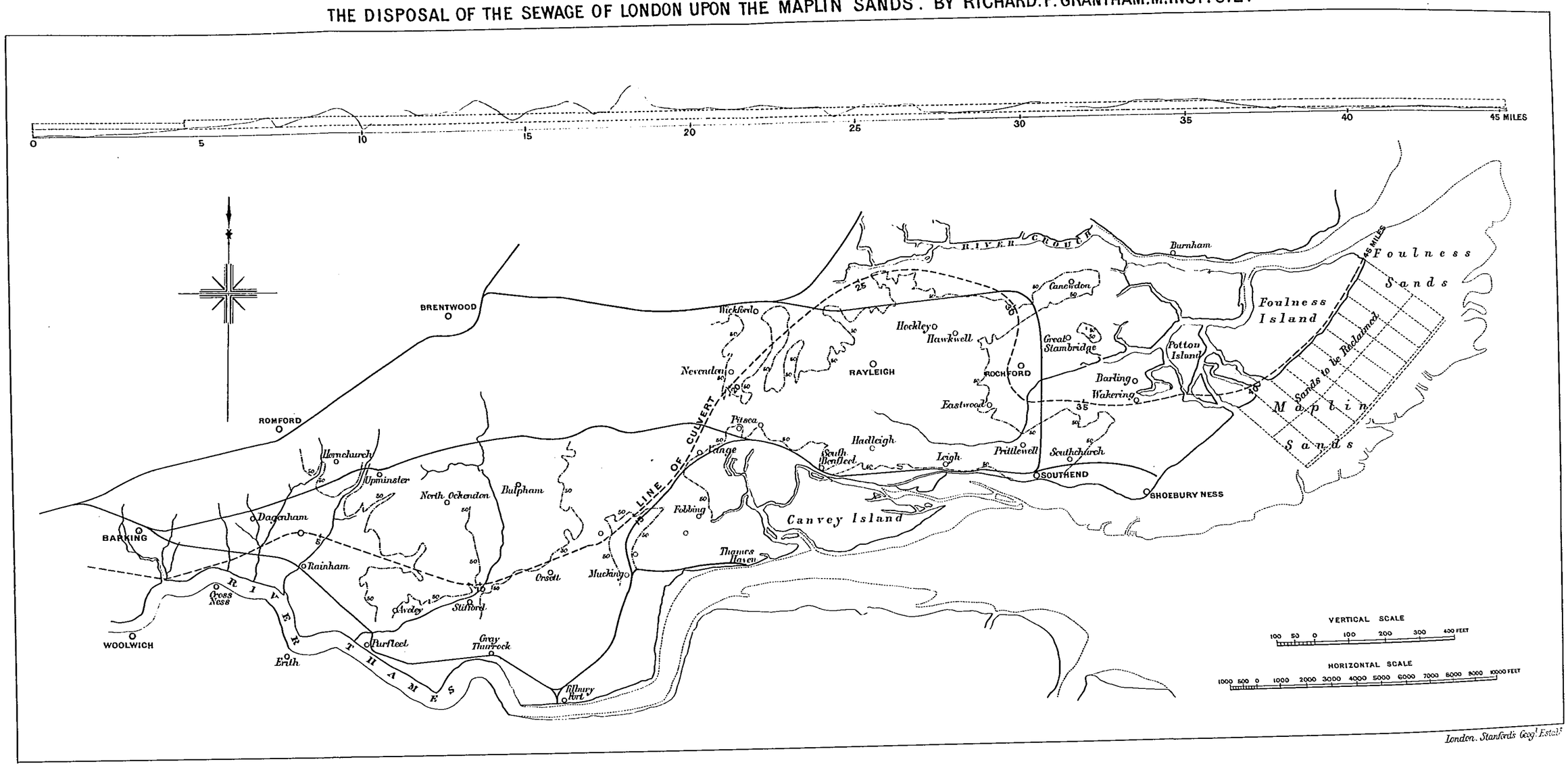


THE DISPOSAL OF THE SEWAGE OF LONDON UPON THE MAPLIN SANDS. BY RICHARD.F.GRANTHAM.M.INST.C.E.



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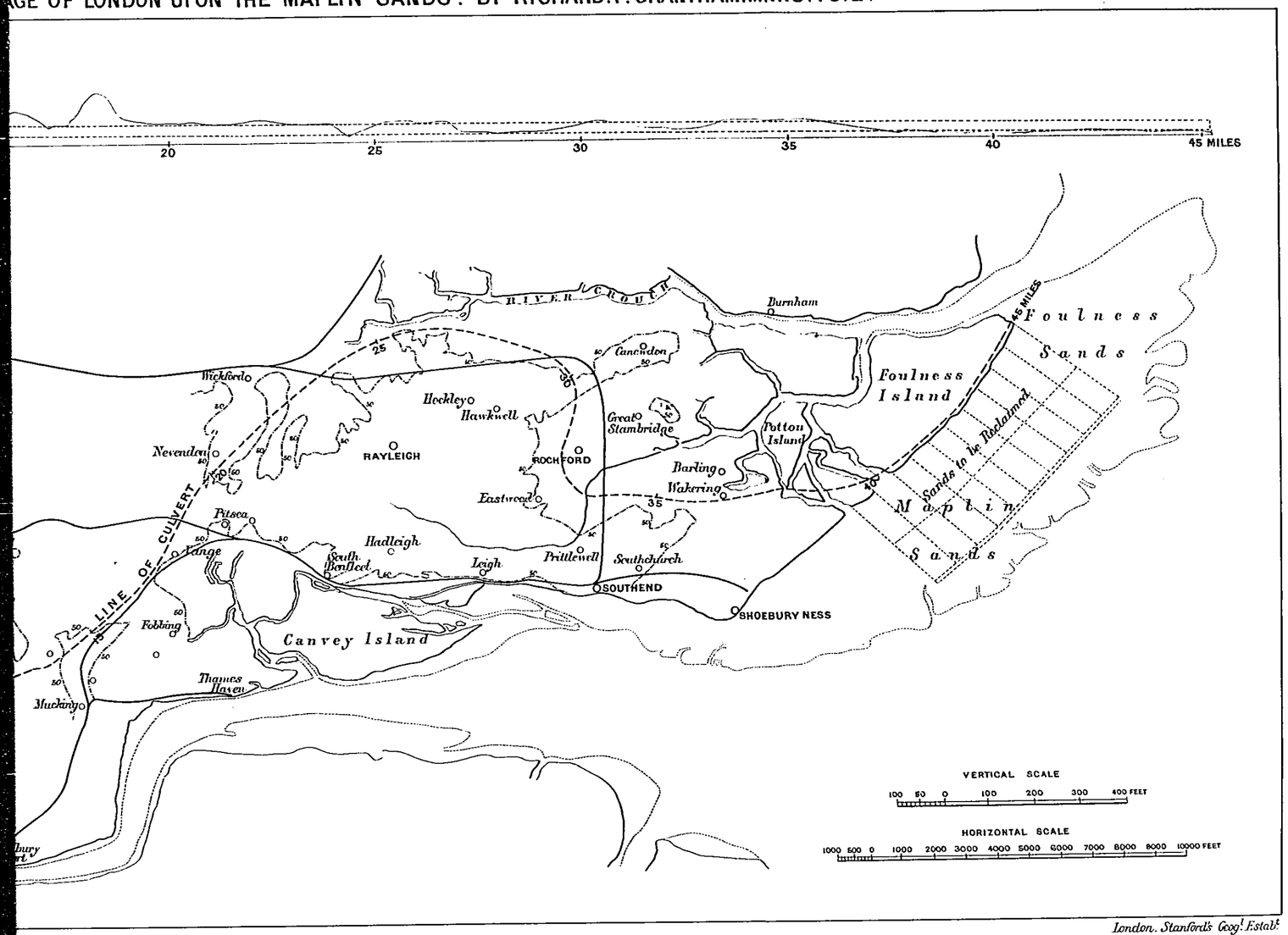


London. Stanford's Geog.l Estab.t

Now, under ordinary circumstances and with due regard for the cultivation of crops, it appears, by the table already quoted, that the greatest quantity of sewage applied to agricultural land does not exceed 17,000 gallons per acre per 24 hours as the regular daily average. But the Maplin Sands present a surface different from ordinary agricultural land, and with an efficient system of arterial and under-drainage, would answer the purpose of a filter bed. The Craigentinny meadows, which receive the sewage of Edinburgh, afford an analogous case, so far as the soil is concerned, and have become, from the constant application of sewage, very fertile, although, as they are not prepared in any way for its reception, the effluent is not completely purified. The quantity applied there per acre per diem, as shown in the table, is 10,000 gallons. But in very porous soil, such as that at Merthyr Tydfil, Kendal and Abingdon, 50,000 (according to Mr. Bailey Denton), and 200,000 gallons have been respectively daily absorbed per acre, although such quantities render cultivation impossible.

Taking as an extreme case the average rate at which the water of the London companies is filtered upon carefully prepared filter-beds of sand and various thicknesses of gravel, we find that the volumes absorbed by each acre are at the rate of from 1,500,000 gallons to 2,000,000 gallons per acre per 24 hours.

Dr. Frankland's experiments, which led to the practice of intermittent downward filtration, showed that volumes varying from 42,592 to 95,832 gallons per acre per 24 hours, according to the nature of the subsoil, could be purified in passing through subsoil drained 6 ft. deep, although these were simply laboratory experiments.

Within the last few months the Massachusetts Board of Health has issued a report embodying the results of its recent experiments on the filtration of sewage. According to this, sewage may be a good deal purified by being allowed to pass intermittently through a filter of open sand, so that the surface by becoming dry may allow air to enter the filter, and filtering beds of sand covered with soil may be much increased in efficiency, by digging trenches along a slight incline in the bed and filling them with coarse sand. When exposed to cold and snow, the filtration was found to be imperfect at even the moderate rate of 30,000 gallons per diem. Where protected from cold and snow the sewage was passed through the filters at the rate of 30,000, 60,000 and 120,000 gallons per acre per diem, and at these rates the ammonia showed that 97, 94 and 80 per cent. of the impurities were removed. Upon increasing the rate of filtration to 180,000 gallons, the percentage of ammonia

increased, but did not exceed 2 per cent. of those of the treated sewage.

Before applying these figures to the scheme proposed in this paper, it may be remarked that the effluent need only be so far purified, that after admission into the great body of tidal water in the Swin Channel, it will not endanger the Oyster Fisheries, or cause a nuisance to Southend or Burnham.

A somewhat long experience of arterial and under-drainage in the Lincolnshire marshes, where the surface and subsoil are silt originally reclaimed from the sea, has shown to what extent the absorbing power of subsoil may be increased. It would be easy by trying on the Maplin Sands a system similar to that proved in Lincolnshire, to make them capable of absorbing the quantities which it is proposed should be discharged upon them. The reclaimed areas on the Maplin Sands would be divided into fields of say about 100 acres, by the intersection of main arterial drains, which would receive the discharge from the underdrains to be laid in each field. The excavation from the arterial drains within the reclaimed area would be used in strengthening the embankments.

The surface and subsoil on the Lincolnshire marshes is silt, as already stated, of more or less density. It is formed by a very slow process of accretion until it rises above the level of ordinary high tides. Then it gets gradually covered with grass and in time becomes exceedingly fertile, and has been let, as soon as enclosed, at £3 per acre. In a somewhat similar manner, by the application of sewage matter, it is believed the Maplin Sands may become fertilized; and indeed, the Edinburgh sewage meadows seem to demonstrate the feasibility of converting them into agricultural land.

From the above examples we may conclude that upon such soil, with a proper system of internal drainage, a quantity of sewage equal to 50,000 gallons per acre per day may be readily absorbed and fairly purified over that portion of the reclaimed area which it is proposed should be devoted to filter beds. These filter beds, it is suggested, should cover 4,000 acres divided in their working into two equal areas to be used intermittently, while the remaining 6,000 acres would without difficulty absorb 12,000 to 15,000 gallons per acre per 24 hours, and at the same time admit of the cultivation of crops. In view of future needs, a still larger area might be apportioned to filter beds.

The estimate for the work, exclusive of the cost of land and foreshore rights, is £4,500,000. The area of the land through which easement would be required would be about 300 acres. The working expenses of cultivating the enclosed irrigated area would, it is anticipated, be in great measure covered by the returns of the crops yielded.

There would of course be no difficulty in delivering any sewage from the outfall sewer to farmers who might wish to apply it to their land.

The disposal of the sewage of London on the Maplin Sands is an old idea, but recently the owners of oyster fisheries have been much agitated at the suggestion of it, although no steps have been taken to place it a stage further than suggestion.

The scheme herein proposed would, it is believed, so far purify the sewage as to render it admissible into the Swin Channel without fear of injury to the oyster fisheries or to any other interest.

It would be impossible within the limits of a single paper to describe in detail a scheme intended to deal with so large a volume as the sewage of London. This description of the outline of such a scheme may, it is hoped, contain suggestions worthy of reflection and discussion.

Mr. J. Lemon (Southampton) drew attention to what had been done by the Metropolitan Board of Works and the London County Council, reminding them that precipitating tanks were being constructed at a cost of a million sterling, whilst the sludge was being taken in barges out to sea. Was this large cost, he asked, to be thrown away? Ought they not to consider whether they should utilise these things? He considered it an unscientific system to take sludge out to sea. There was no reason whatever, he held, why London sewage should not be treated by chemicals, and by their adoption a sufficiently pure effluent could be obtained to render the discharge also sufficiently pure for all practical purposes. As to the disposal of sludge there should be no difficulty. It ought to be transmitted to some suitable soil and there so dealt with, as at Birmingham, as to make it form a portion of the land itself. It was far better, he maintained, to deal with a small quantity of sewage and convey it to a place where it could be easily disposed of than to go to the enormous cost of conveying the whole of the sewage of London to the Maplin Sands. And when they got it there could it be finally disposed of? He believed a great mistake had often been made in taking it to unsuitable places where it could not be properly disposed of, and this error he thought would be likely to be repeated at the Maplin Sands, for unless the land had such drainage as to ensure the oxidation of sewage there could be no purification at all. And what about increasing the County Council rate to carry out this large scheme? The cost of conveying the sewage would alone be four and a half millions, and this sum did not allow for the purchase of the land or the working expenses, which he estimated at £100,000 a year. The yearly payment of interest on the outlay he put down at £250,000 so

that Mr. Grantham's scheme would cost the ratepayers not less than £350,000 a year. That was a sum which the ratepayers of London would not approach with a very light heart. For himself he would propose to convey the sludge through pipes to Canvey Island, which was only half the distance of the Maplin Sands and dispose of it there. Moreover, he considered it quite possible so to filter the effluent as to bring it to a high degree of purity and then discharge it into the river. Although he thus differed from Mr. Grantham he quite recognised the importance of his paper, and he accordingly moved a special vote of thanks in that he had taken so much trouble to introduce it.

Colonel JONES (Carshalton) seconded. He considered that the only trouble about the scheme laid before them was its immense cost and the reclamation of land that it would necessitate. For this reason he also considered that Canvey Island would be the better place of the two, and it had this advantage over the Maplin Sands—its land was agricultural and alluvial, whilst the work of reclamation was already done. Again, the cost would be much smaller; he should think it would not exceed at Canvey Island £30,000 a year. So he advocated this as a half-way house, and he thought it would make a very good compromise.

Dr. CARPENTER (Croydon) thanked Mr. Grantham for dealing with the matter in so practical a way. There were many excellent points in his paper which should commend themselves to the consideration of the County Council, but there were some points which were based to some extent on mistakes, and mistakes which would have to be considered by those who faced the enormous difficulty of dealing with such an immense mass of sewage. One great mistake, was the proposal to bring all the sewage to one outfall. Certainly there should be more than one, and he considered that fifty sewage farms would be better than bringing such a huge mass to one point. He rather believed that the compromise mentioned by Colonel Jones would probably be that which would come about, for it was absolutely necessary that sewage should go to suitable land, and so assist in the production of meat and milk for the inhabitants of the country. He thought too that they might adopt such an arrangement as would utilise the tanks that had already been formed. Certainly the principle of so applying sewage to the land as to increase the luxuriance of vegetation, ought to be adopted by London as it had been by Birmingham. With regard to the cost, what was £350,000 a year, when the end to be gained was the surmounting of so great a difficulty? Why, a threepenny rate would do it. But he did not think there need be this sum to be paid annually, for by making sewage of use to the soil, a sufficient return would be realised to pay all working expenses. If some skilful engineer would only face this question in the right way and provide for the distribution of sewage over several acres, no matter how far from London, they would, he believed, get rid of their difficulties and prove moreover the means of producing cheaper food; an end which would be of the utmost advantage to the interests and welfare of the nation.

Mr. R. F. GRANTHAM (London), in reply, said that he did not claim for his scheme that it was unalterable. In fact, he admitted that it had only been thought out in a rough and general way. Mr. Lemon had asked if, in the adoption of the scheme suggested, the tanks which had been formed at a great outlay were to be done away with? He did not think so. There would have to be tanks for giving effect to his scheme, and so at any rate they would not be entirely done away with. As to the treatment of sewage by chemicals, he would be very glad if it could be successfully adopted. They had been waiting for years for some satisfactory scheme, and Mr. Brigden had put forward one, but it had by many authorities been condemned, and at present they were waiting still. Then with regard to the proposal of pumping up sludge as at Birmingham, it had to be remembered that the locality made all the difference. The sludge there was very thin, and what was possible at Birmingham, might not prove successful at London. Where so great an amount was concerned they must not consider the question of cost, and he was sure that if they could get a fairly good scheme, London would not stop at that. There was one point which he thought Mr. Lemon hardly realised, and that was the quantity of water to be used. It was all very well to filter sewage, but the quantity of water to be applied to the land had to be considered, and as he had shown large quantities were not applied. With regard to Canvey Island, he could only say that he had considered the question, and he thought it would be much better if Canvey Island were in the direction of the Maplin Sands. In considering Canvey Island, they had also to consider that popular resort Southend, and he felt sure there would be great and successful opposition to the Canvey Island proposal.

On "Black Ash Waste, and its Application to the Treatment of Sewage and Foul Water," by Mr. JOHN HANSON.

MR. JOHN HANSON read a paper on the above subject, with a preface that it might be presented in quite a humorous and piquant form had he the gift of poetry and classic illustration like some newspaper writers. But they were met rather for instruction than entertainment, and so he only proposed to deal with it in the interests of the public health as a practical sewage chemist. A Greek title might make it more attractive, yet he should show, by plain facts, that his process was adopted to utilize mountains of chemical waste, and to restore the rivers of England to the sport of the angler and the enjoyment of the naturalist, while fulfilling its purifying function on sewage.

Black Ash Waste, he proceeded to explain, is a by-product in the manufacture of alkali, or common soda, in the making of one ton of which four tons of the waste were produced. The residual was principally sulphide of calcium, which, it should be noted, is a polluter, and not a clarifier, of water, so that the waste itself was worse than useless—the virtue was in his extract. By his process the sulphides are metamorphosed into sulphites and hypo-sulphites—the strongest and best purifying chemical known. This disinfectant is disintegrated, pulverised, and oxidised under his patent, and is known as Hanson's "Sulphurous Powder." Its effects were prompt, marked, and remarkable, as seen in the reports of analysts, engineers, and others.

A given quantity of the powder mixed with water and well agitated, is allowed to flow with the polluted water into a precipitating tank in conjunction with milk of lime. The first result is, that the sulphurous powder absorbs one atom of oxygen from the foul liquid, and by so doing sulphurous acid gas ($H_2 SO_3$) is at once formed, this being equivalent to the effect of burning brimstone under water. The fumes permeate the liquid and destroy all microbes (or germs of zymotic disease), completely ridding the effluent of all organisms whatever. The action of the lime is to contract the solid particles in suspension, and by making them heavier in proportion to their size, to increase their specific gravity, and so precipitate them as sludge. Caustic lime made the effluent alkaline, destroying fish, incrustating boilers, and hardening the water so that it could not be used again in many manufactures. The combination of his two chemicals took up another atom of oxygen, converting the result into sulphuric acid ($H_2 SO_4$), which combined with the causticity of the lime, and threw down the hydrate of lime in the form of sulphide of lime, and thus rendered the effluent neutral as well as pure. The result, in short, complied with the Rivers' Pollution Act in a way surpassing all other attempts. The standard of purity he set up was a commercial one, and cost only 6d. per head of the population per annum. As to drinking the effluent, that too could be provided for, though the luxury would be a rather costly one.

In proof of these statements he invited an inspection of his works, more in number than any other sanitary firm could boast of. There are some half-dozen different solutions of the sewage difficulty offered to the public, with chemical materials of the most diverse kind. And whereas public reports showed that all, or nearly so, of these different methods had been abandoned somewhere, it was a significant fact that Hanson's system had in no instance been abandoned when fairly tested.

This process defeated the A.B.C. in open competition at

Leeds in July, 1876, the effluent being (according to the Leeds press quoted) colourless, inodorous, and of a higher standard of purity than Government required.

In the same year it was adopted by the Tong Local Board, and Mr. Edward Croft, the Chairman of the Board, reported that "the method has always been, and is acknowledged, by the most eminent chemists and engineers, to be the simplest, cheapest, and most perfect ever known; and the Tong sewage is of the vilest type. Mr. Hanson produced a bright, clear, inodorous, and almost pure effluent, said to be the purest in the country."

In 1880 he delivered the Tweed from the pollution of Hawick.

In the following year he put up Sewage Works at Golcar, and others at Crimble, at a cost of £3,220, still in use with his process.

Subsequently Aldershot required his treatment, and afterwards he undertook large contracts at Tottenham, Leyton, and Canning Town (on the Lee), Silver Town (on the Thames), and elsewhere.

The Lee was notorious for its pollution, causing litigation and legislation, and ruining all trades that had depended upon it. In six months (according to the *Daily Chronicle* quoted) all this was changed, and Major Lamorock Flower, as Sanitary Engineer to the Conservancy Board, reported that on their annual survey of the river, they expressed their "unqualified delight at its changed condition, mainly due" (as the Major pointed out) "to the treatment of the Tottenham sewage by the sulphurous powder." In a Select Committee of the House of Commons on the state of the river, Mr. W. C. Young, the Consulting Chemist of the Board, gave his preference to Hanson's process (in answer to questions by Sir Henry Roscoe), particularly because "the effluent was perfectly free from microscopic organisms."

As to the Leyton works, he quoted from the *Eastern Mercury* the testimony of Mr. J. G. Browning, Assistant Engineer to the Local Board, that they were "the finest in England, if not in the world;" and that "the most celebrated engineers in the country," on inspecting them, "go away with a very favourable impression of the manner in which Leyton disposes of its sewage by Hanson's Sulphurous Powder."

After mentioning West Ham and his "detective water-wheel" near Lee Bridge, Mr. Hanson dealt with the disposal of his sludge (which Dr. Munro, F.C.S., had said was the second in manurial value, 28s. 6d. per ton), stating that when not wanted as a fertilizer he carbonized it in a destructor.

In drawing his remarks to a close Mr. Hanson advised great caution and personal enquiry on the part of those seeking deliverance from the sewage difficulty, whereby they might save the waste of millions. "Beautiful sewage-farming" was a thing of the past. The watery ways of our weather give the poor farmer 'liquidation' enough without irrigation. Mere precipitation and filtration was but toying with pestilence.

Major LAMOROCK FLOWER (London) said the author of the paper had enabled him to state, that the Lee was no longer the narrow dirty ditch it was when he took charge of it twenty years ago. He endorsed all Mr. Hanson had said as to the value of the treatment of sewage, by his mode of dealing with the residuum product, and he mentioned that at Tottenham where the river had been very filthy, Mr. Hanson's method had been adopted, with results so satisfactory that his own Board wrote to the Tottenham Local Board to record their great sense of satisfaction. When the water was drained out in the portion of the river where Mr. Hanson's method was adopted, it was found that the bed of the stream was singularly clear, whilst at Hertford, where it had not been adopted, the bed of the river was in the most filthy condition. At Hertford, moreover, sulphate of iron had been used, which showed that this compound was not always to be relied upon.

Mr. WILLIAM WHITE (London) said it seemed to him that Mr. Hanson's method might very well form a subject for the investigation of the Institute in London.

Mr. H. H. COLLINS (London) pointed out that whenever a Certificate of The Sanitary Institute was given to an invention, it was only given after the Judges had made a careful examination, and had tested it for themselves. In short, The Sanitary Institute Certificate was a thoroughly *bona fide* document.

Mr. HANSON (Wakefield), in reply, said that if a cup full of his sulphurous powder was taken and a little acid poured on it, it would so fumigate the room in which they were assembled, as not only to drive out all the parasites, but to drive them out too. There was no difficulty, he held, in treating the sewage of London by his method, and no subsequent treatment would be required.

On "Artisans' Dwellings," by FRANCIS HOOPER, A.R.I.B.A.

THE construction of "Artisans' Dwellings" is a subject well deserving the attention of the architectural section of this Congress, not alone in reference to sanitary fittings and drainage, but also with regard to locality, surroundings, and disposition of plan, comprehending as these dwellings do the housing of a vast section of the entire population.

It is not necessary for me to enlarge upon the present grievously unsanitary conditions of the houses occupied by large numbers of artisans and their families in our densely crowded cities—conditions incidental not solely to overcrowding, but to the fact that houses old and dilapidated, constructed often for a class of tenants whose circumstances were entirely different to the present occupants, and render the accommodation quite inadequate to the requirements of humbler households.

The provision of healthful and comfortable "*homes*" should be the aim of all who undertake the housing of artisans.

Many of my audience must have observed the spreading fashion for the erection of so-called model tenement dwellings; I use the word "fashion," but might be more correct in calling it "fever," as speculators have found that here, for the present at least, money is to be made, and building plots small and large, suitable and unsuitable, are being covered with residential flats and artisans' dwellings, which I believe will be found dangerous encumberers of the ground very soon after the brightness of the tuck-pointing outside and of the machine-printed wall-papers inside has worn off.

Regarding the general question of housing artisans in large towns, many economies are effected in tenement buildings, in that, one roof, one drain, one staircase, one water and gas service, suffice for many households, and whilst all are in good order all benefit alike; but should accident occur, defect arise, water fail, a drain choke, or a fever break out, the evils spread, and all are liable to suffer. It is most essential therefore that in such thickly populated buildings, which are sometimes as much as six storeys high, the sanitary arrangements should be of the best construction, and all apparatus and fittings of the most substantial kind. Hence I view with more anxiety the activity of the private speculator in tenement dwellings, than of those who erect villas in our suburbs the ill-repute of which has long ago become a by-word.

Relation of Rent and Wages.

In considering the structural requirements of "Artisans' Dwellings," it is necessary to determine the class of artisans whose requirements are to be met, as the accommodation and household fittings are regulated by the rents obtainable from the tenants. I propose now to confine my remarks to block or tenement buildings in thickly-populated towns suitable for artisans whose weekly wages range from 30s. to 50s.

Evidence given before the "Royal Commission on the Housing of the Working Classes, 1885," goes to show that in a large district in London, where special enquiry was made, upwards of 88 per cent. of the working men were found to pay more than one-fifth of their earnings in rent, and that the average rent of one room, let as a separate tenement, was 3s. 10¾d.; of a two-roomed tenement, 6s.; of a three-roomed tenement, 7s. 5¼d. The Report of the Commission adds, "Corroborative evidence is not wanting that the witness erred, if at all, on the side of moderation."

The scope of my subject is therefore confined to tenements rented from 6s. to 10s. per week; and here it may be well to remark that the weekly income of an artisan with a family is not arrived at by simple enquiry as to the amount he himself earns; for in an industrious family not only the wife, but frequently the elder children, contribute to the weekly earnings.

Selection of Building Site.

In selecting a site for Artisans' Dwellings, it is of the highest importance to secure sufficient area, well-drained subsoil, and suitable shape.

From measurement of the best-arranged buildings of this class, I find that these occupy on an average about one-third of the entire site, thus leaving two-thirds for air, light, approaches, and recreation.

It is important, from a commercial point of view, that the buildings should be in proximity to the factories, wharves, or other places affording employment for the tenants, or that cheap and rapid means of transit either by rail, omnibus, or tram-car, should exist.

Open Spaces.

It would appear from an inspection of a large number of existing dwellings erected both by private individuals and limited liability companies, that the front of every block should

either abut upon, or else face a public thoroughfare, and thus afford a more cheerful outlook than the alternative courtyard. It further seems that where no rights of light exist to limit the height of building, builders are tempted to carry up their work to a height which seriously injures the light and wholesomeness of the lower tenements.

Where buildings occupy more than two sides of any enclosed space, it is most desirable to avoid the abutting of two buildings at the angles, which invariably darkens certain of the staircases and rooms, and to leave an open space between to permit the free circulation of air, and avoid stagnation, which tends to create disease.

It is not always possible for the architect to choose the aspect of his building, but an attempt should be made to secure frontages to east and west, so that the windows may receive the horizontal rays of the sun, whilst the vertical rays strike down into the courtyard and street.

Approaches and Entrances.

The development of any large scheme usually involves the repetition of a certain arrangement of rooms around a common staircase, which gives access to the several tenements, each of which, as far as possible, is self-contained.

The entrance may be formed at the back or front of the block, but where the staircase is built against an outer wall there are certain advantages in having the entrance at the back, as the stairs are more private, and the whole of the front wall is available for rooms.

In such cases the courtyard is entered by an archway through the front block, and the tenants are more directly under the control of the superintendent, whose office may be at one side of the principal entrance.

The several blocks will vary from 28 ft. to 36 ft. in depth, according to plan, and the frontage from 45 ft. to 75 ft.

Height of Buildings.

The height of the buildings should not exceed five storeys above the ground, on account of fatigue in ascent and obstruction of light and air. Shops may occupy the ground floor in busy thoroughfares, and will probably be let in conjunction with a cellar below, or perhaps a tenement behind or above, thus helping to augment the revenue.

Courtyards.

The courtyards may with advantage be levelled, and spread with a 9 in. layer of cement concrete, laid to falls for drainage, and finished on the surface with a coating of compressed natural asphalt or tar-paving, which latter is fairly efficient and much the cheaper of the two materials.

Staircases.

The staircases should be built against an outside wall, so that ample windows may light them and that a shaft may be avoided, which would spread fire upwards should such break out in the building.

Fire-resisting materials should in all cases be used for staircase construction, and for this purpose gas breeze concrete is more reliable than stone, for both treads and landings.

The height of the storeys in the clear should be about nine feet; thus, if the rise be seven and a half inches, two short flights of eight steps will extend from floor to floor, and the tread with nosing need not exceed eight inches.

The width of the staircase should be not less than six feet nine, which, with a nine inch brick newel, will allow of treads three feet wide; winding steps should on no account be tolerated, being both dangerous and difficult to light.

A solid newel should always be introduced, as it increases the strength of the stairs by giving the treads a bearing at either end; offers resistance to, and mitigates the spread of fire from floor to floor by the staircase well; prevents tenants from seeing one another and talking from floor to floor, and thus adds much to the quietness and privacy of the building.

Open Balconies.

With a view to reduce the number of staircases, and to avoid the formation of internal corridors of approach to several tenements, external galleries or open balconies have in many instances been constructed, but these must on no account be arranged on the side next a public thoroughfare, nor should the balconies of two parallel blocks be towards each other.

This arrangement can not, however, be commended as the rooms are deprived of much light, and unless the rooms are entered directly from the balcony, there is of necessity a loss of floor space by the formation of a passage-way.

Internal Corridors.

Internal corridors are specially to be avoided, as they are most difficult to light, and are consequently but rarely kept clean. They further afford shelter for loafers and gossipers, and hence are morally injurious.

It is well that the window openings upon the staircase should be unglazed, in order to secure ample ventilation, and to prevent the transmission of foul air or disease; each opening being protected by a strong iron guard-rail.

The walls of the staircases should be lined with some hard impervious substance which can be readily washed.

Glazed bricks are very efficient, but a tinted granolithic cement dado 4 ft. high presents a more homely effect, the wall above being plastered and coloured.

A strong handrail should be provided, and may be formed of $1\frac{1}{2}$ in. wrought iron gas-piping in straight lengths fixed about 2 in. from the wall by means of short brackets.

The front door of each tenement should open immediately upon the staircase landing, and, where space permits, an entrance lobby should be provided to increase the privacy of each dwelling.

A good average height from floor to floor is 10 feet, giving about 9 feet in the clear; and, bearing in mind that the Public Health Act requires 300 cubic feet of air for each adult, and 150 feet for each child, as a minimum in the sleeping room, it is necessary to provide floor space equivalent to at least 6 ft. 6 in. by 5 ft., and 5 ft. by 3 ft. 3 in. respectively.

Shoots for Dust and Ashes.

Shoots for the disposal of household dust and ashes may suitably be formed in the corner of the half-landings of the stairs. These shoots should be shafts about 9 in. by 9 in., formed in the brickwork rendered internally in cement, discharging at the bottom into a dust cellar or a movable receptacle, and continued up through the roof for ventilation. The hopper-door on each half-landing should have side cheeks and a metal flap inside to prevent the dust from being blown back before the door can be closed, thus making dirt and litter on the stairs, and it also should be made self-closing.

Each landing should be lighted at night with a gas jet of about 20-candle power; the frame of the lamp being easily removable for cleaning and repairs. A very neat pattern, used by the Improved Industrial Dwellings Company, consists simply of a front hooked on to buttons on the wall; the glass

is in narrow slips, not puttied in, but secured in a groove, and the enclosure is ventilated by a short pipe carried through the concrete landing above, and finished on the top with a metal hood.

Internal Arrangement of Tenements.

The internal arrangement of the tenement should as far as practicable assimilate to that of a well-planned country cottage, the size and number of rooms depending upon local circumstances, wages, and requirements.

Single-room dwellings are in request in some districts, but I find in the Peabody Buildings in Westminster most of the single rooms have been let together in pairs, the largest demand being for two and three rooms, which, for economy of space, are arranged to open the one from the other.

A convenient size for the living-room or kitchen is eleven feet wide by thirteen feet from front to back; the fire-place being so placed as to allow of a bedstead at the back of the room, if required. The windows should be of ample width (three feet six inches at the least) and should extend to within six inches of the ceiling to obtain the utmost light and ventilation. The sashes may be made in three heights; the lower being fixed for the protection of children, obscured glazing answering as a window blind; whilst the upper ones are double, hung with pulleys and weights. The cooking-range should not be less than 3 ft. in width, and fitted with an oven; all parts subject to heavy wear, such as the fire-bars, draw-out fret, drop-bars, trivet, etc., being of wrought iron. The following fittings should also be provided: a fixed dresser, with shelves and cup rails; a food store, ventilated if possible from the external air; a coal-bunker, formed with a sliding door or top flap; a sink of Bristol glazed ware; a wooden drainer; and a plate-rack.

In the Peabody Buildings and many others of similar type the sinks as well as the w.c.'s are on the staircase landings, used jointly by the occupants of two or more tenements, and open to the constant inspection of the superintendents.

Laundries.

In addition to the sinks, a laundry is frequently provided on each storey for the general use by turn of the several tenants, furnished with one or more coppers, and teak or stoneware washing-troughs, and, as in some of the recently erected buildings of the "Artisans, Labourers, and General Dwellings

Company," an enamelled fire-clay bath is also provided, to which cold water is laid on, hot water being obtained by each tenant from a copper. From many enquiries I find that baths are but little appreciated, and appear likely to continue so with the present race of tenants.

In order to obviate annoyance from the smell and escape of steam from these laundries, the Improved Industrial Dwellings Company have for a long time past been constructing them on a large scale, on the flat roofs of their buildings, where steam freely escapes, and there is ample space around for drying the wet linen. This example has been followed by the Peabody Trustees in their buildings in Peter Street, Westminster, where, in addition, is provided a covered drying-ground, which can be kept under lock and key and used by the tenants in turn for 24 hours, viz., 8 a.m. to 8 a.m., and is much appreciated by them.

The Trustees still provide only one w.c. and sink between two families, whereas the former Company appears to make it a principle that each tenement shall have its w.c. and sink contained within itself.

Two distinct arrangements of plan are shown in the accompanying illustrations (page 208). In the one case the sink is placed in an enclosure opening from the living-room, having a window, and comprising also a food and coal store, whilst the w.c. is entered from a lobby, and is both lighted and ventilated by a window to the outer air over that of the sink enclosure.

In the second case the front enclosure of the living-room is set back from the general wall-line to form a balcony, upon which is the w.c., coal store, &c.

The entrance-lobby, which adds greatly to the privacy and comfort of the tenement, should be provided with hat and coat hooks, and the rooms should have wooden rails on the walls for pictures or prints, to prevent as far as possible injury caused by driving nails into the plastering.

Bed-rooms.

The bed-rooms will vary in size, but one at least should be as large as 13 ft. by 9 ft., and a hanging closet for clothing should be provided in each. Fanlights over the doors prove most useful ventilators, and if glazed with obscured glass prevent dark passages. Every bed-room should have a fireplace so planned as to allow a clear space round the bed of at least twelve inches, and the grates should be of fire-lumps, with fuel space of about 8 in. by 4 in. and 10 in. deep, the mantel and shelf being of cast iron, as the most durable material for such buildings.

I found in some dwellings in Rouen gas services provided

for cooking; a provision which I consider worthy of imitation in this country.

In many buildings Venetian blinds are provided by the proprietors; these present a more tidy and uniform appearance externally than roller blinds, and are a source of economy to the tenant, who would otherwise have almost invariably to provide himself with new roller blinds on entering.

Each front door should be provided with a strong lock, varying in pattern throughout the building; also with knockers and spring letter-plates, and should be legibly numbered.

Window-gardening may be encouraged by providing wide sills, on which pots and flower-boxes may be placed, thus assisting to relieve the monotony of the *façade*.

Roofs.

Where roofs are flat, the staircases should give direct access to them, and should be finished with a solidly-constructed bulkhead.

Close guard-rails should be fixed around the roofs at least 5 ft. in height, mounted on a solid parapet, for the protection of children and adults.

The construction should be of iron joists, cement and coke-breeze concrete, finished on the top with asphalt or tar-paving. The surface should be laid to sufficient falls to secure ample drainage; the floors of the laundries, when constructed on the roof, should have channels to carry off the water quickly from the troughs, &c., wooden lattices being provided for the women to stand upon whilst at their work.

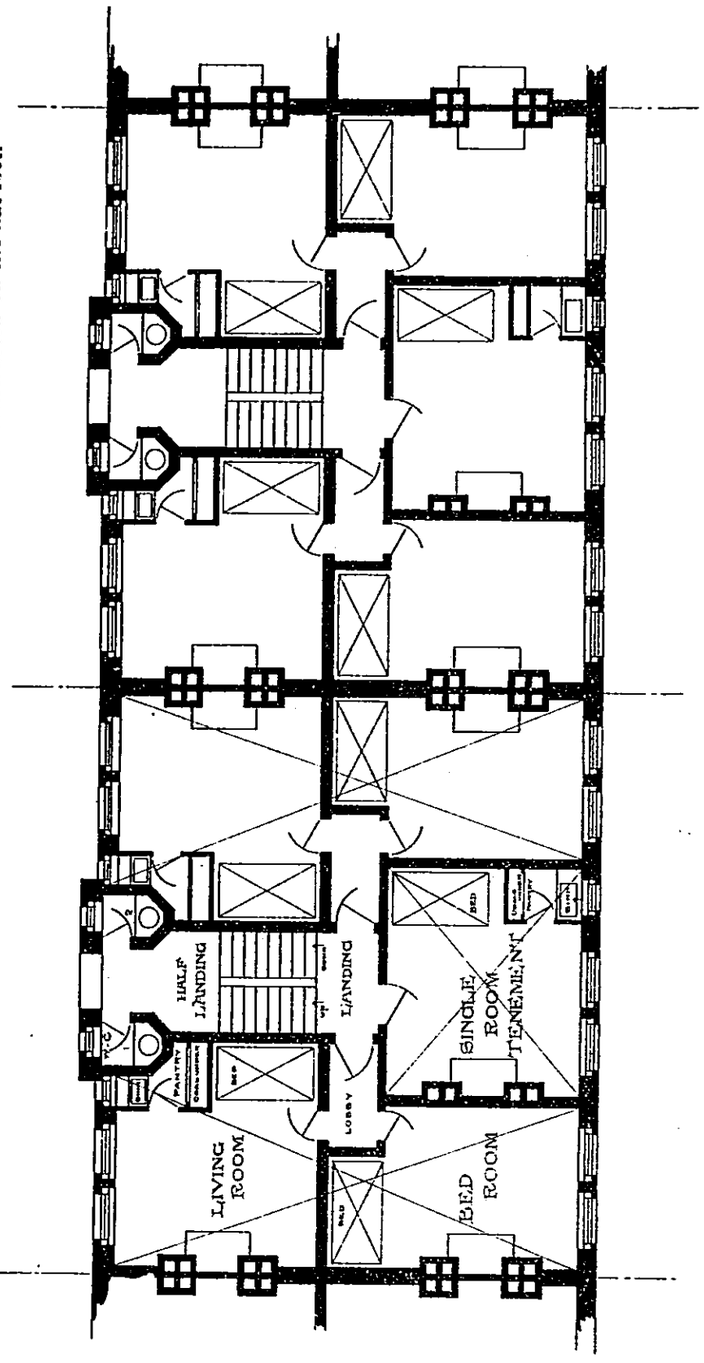
The general unsightliness of a flat-roofed building has been mitigated by the Improved Industrial Dwellings Company in their new buildings near Grosvenor Square, by constructing the topmost storey with an almost vertical mansard roof, covered with tiling, above which is the stone curb carrying the guard-rail, supported by an iron purlin running parallel with the front wall.

Water Tanks.

The water storage-tanks, constructed of galvanized iron, may find their place on the flat roof, and should afford a supply of about 40 gallons for each tenement. Each tank should have a brick enclosure for protection against frost, and should be so raised from the roof that it may be emptied onto the roof either for flushing the drains below or for periodical cleansing.

Stout galvanized iron hooks should be built into the chimney-stacks at proper heights for securing the clothes drying-lines.

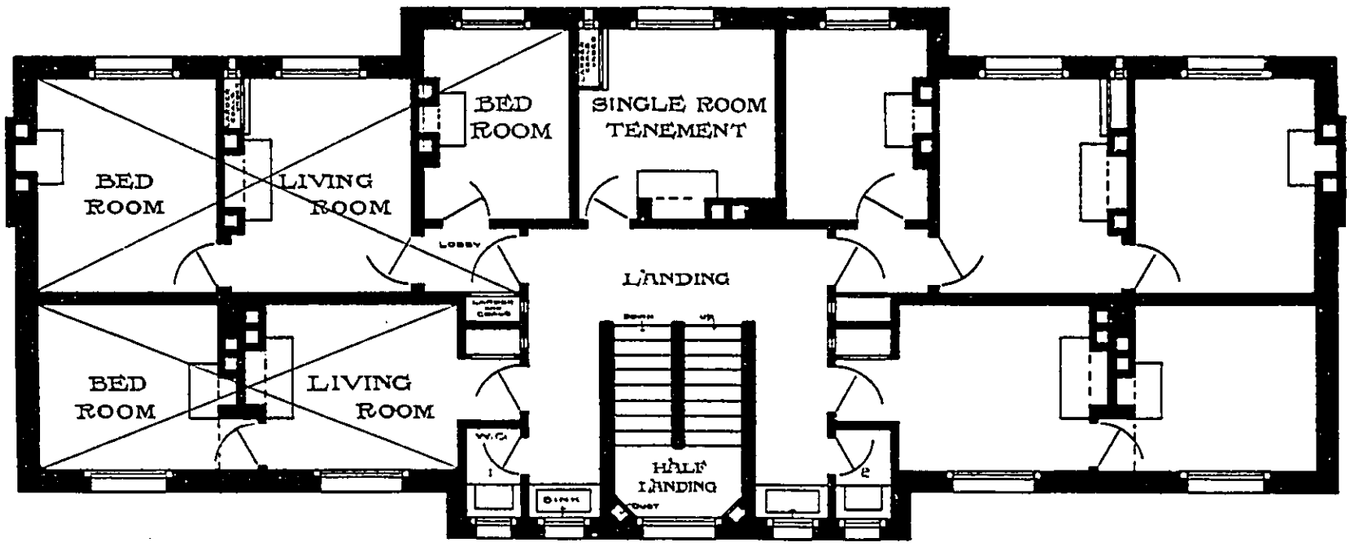
ARTISANS DWELLINGS.



PLAN No. 1 represents an arrangement of five rooms in each storey around the general staircase. The accommodation consists of two two-room tenements and one single-room tenement. Each room has a recess for bedstead and each tenement has a sink with cold water service; food, china, and coal cupboard partitioned from the room and ventilated to the outer air. Two w.c.'s are provided on the half landing of staircase for the joint use of the tenants. The arrangement affords through ventilation to the rooms and it would be advantageous to provide hinged fanlights over all the doors. A laundry and drying ground for the use of the tenants would be constructed on the flat roof.

ARTISANS DWELLINGS.

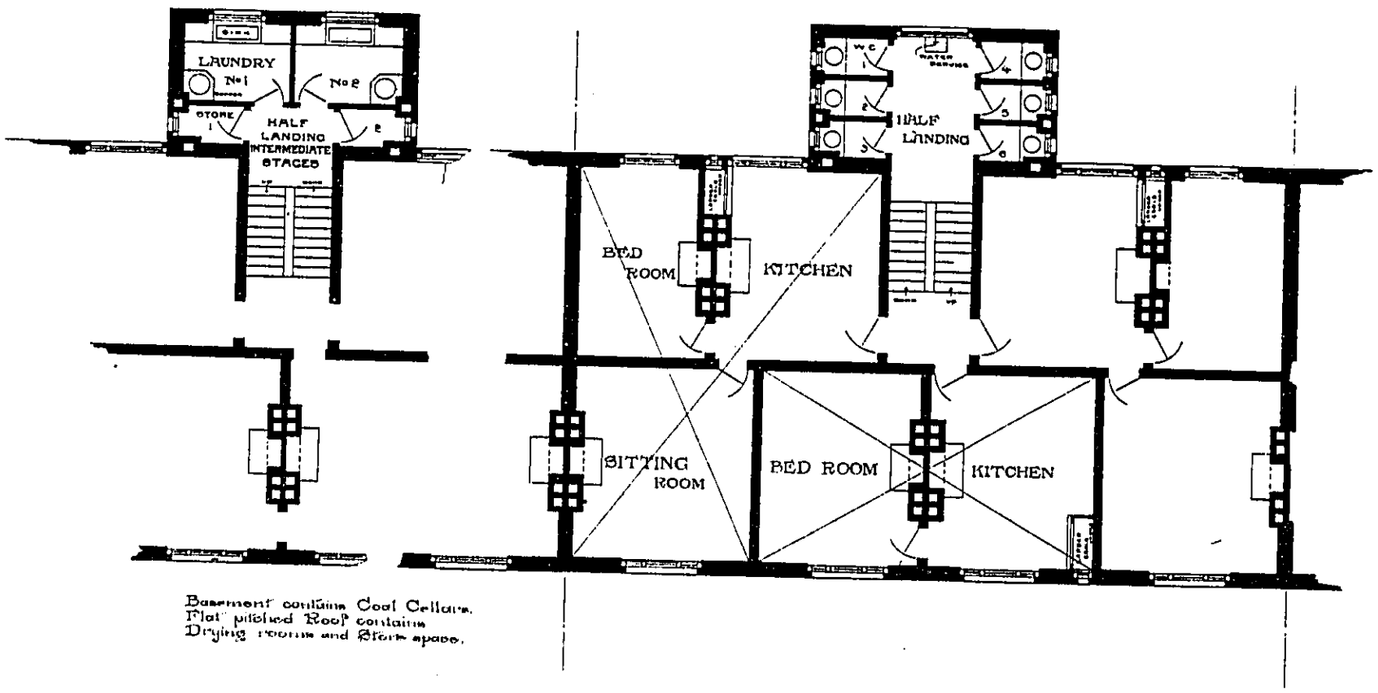
PLAN No. 2 shows an arrangement of 11 rooms on each floor around the staircase. The accommodation consists of two three-room tenements, two two-room tenements and one single-room tenement. Two enamelled stoneware sinks with cold water service and two w.c.'s are provided for the joint use of tenants. Each tenement has a ventilated food china and coal cupboard, and with the exception of the single room tenement, each has a small entrance lobby adding greatly to the comfort and privacy of the occupants. Dustshoots are formed in the angles of the staircase, the treads of the stairs are well lighted and the walls could be lined with glazed bricks. A laundry and drying-room should be constructed in the roof as in No. 1.



Laundries and Drying-room on Flat Roof

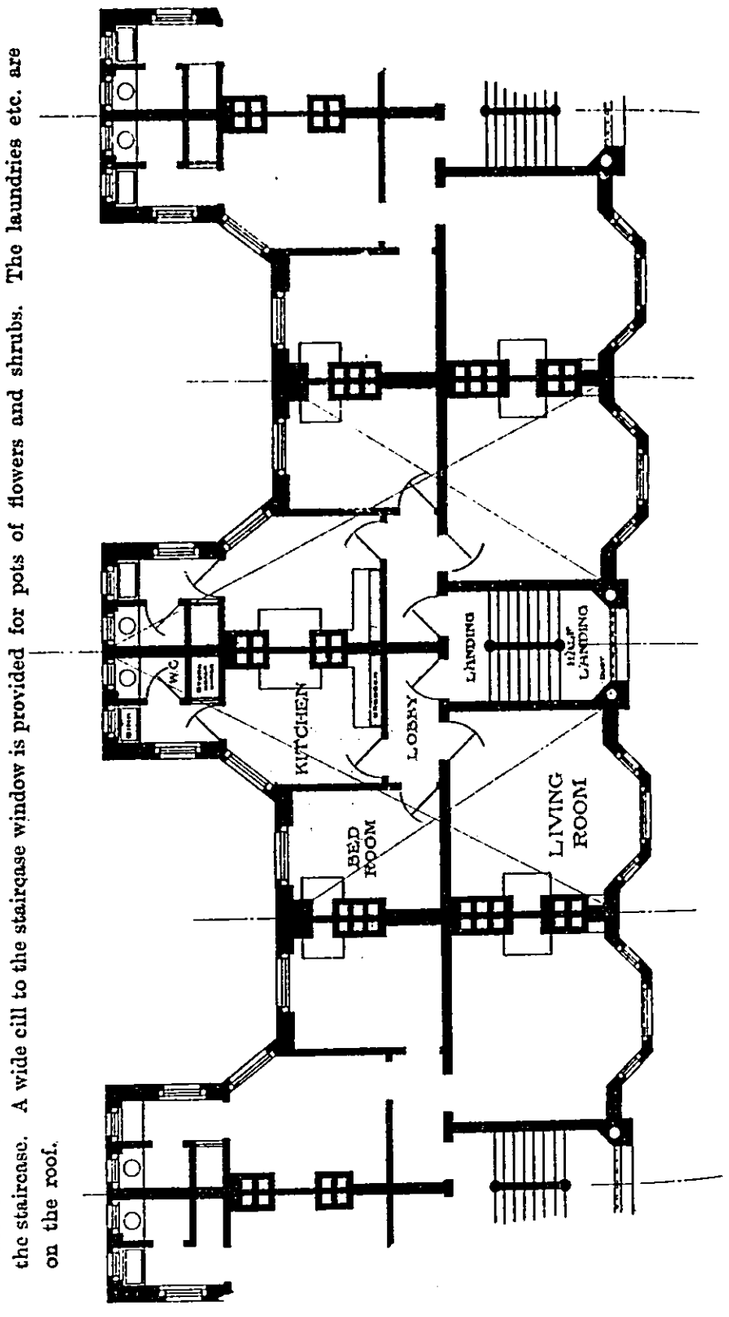
ARTISANS DWELLINGS.

PLAN No. 3 comprises eight rooms on each storey. These may be either grouped as two three-room tenements and one of two rooms, or four two-room tenements. Each tenement has a ventilated food and coal cupboard and a private w.c. on the half-landing of the staircase where the water service is provided; and on the intermediate half-landings are provided two laundries furnished with a copper and sink in each, to be used by turn by the tenants of two stories. Drying-rooms and storage space might be afforded in a low pitched roof and cellars might be formed for the storage of coal.



Basement contains Coal Cellars.
Flat pitched Roof contains
Drying rooms and Store space.

ARTISANS DWELLINGS.



PLAN No. 4 shows a superior class of three-room dwelling. Each tenement is approached through a small entrance lobby, the living room or Parlour has a bay window adding greatly to the cheerfulness of the room, the kitchen is well lighted by a canted window, and from this room opens a well ventilated space containing food and coal store, sink and water service with a w. c. for the sole use of the tenants of this tenement. A dust-shaft is formed on the outer angle of the staircase. A wide cill to the staircase window is provided for pots of flowers and shrubs. The laundries etc. are on the roof.

General Construction.

The external walls, if not more than the height suggested, namely five storeys of 10 ft. each, will not require to be more than one and a half bricks in thickness above the first-floor level.

The bricks should be hard and square, and the mortar joints weather-pointed.

Gas-breeze and cement cast in moulds is now largely used for external lintols, sills, strings, and copings, and may be relieved with a simple incised ornament on the face.

In floor construction, some persons insist on the use of iron joists in one length between back and front walls, filled in with breeze concrete; whilst others maintain that timber with a good plaster below is sufficiently fire-resisting: the rarity of fire in such buildings being some justification for this contention. Where timber construction is used, the floors should be well pugged, to prevent the transmission of sound. Tongued and grooved floor-boards should in all cases be employed as being more easily kept clean than straight-jointed boarding-joints, which soon open and harbour dirt.

Drainage.

The drainage system should be of the simplest kind and executed with the greatest possible care.

The soil-drains in the yards, &c., should not be less than 6-inch glazed stoneware socketted pipes, jointed in cement, laid on a bed of concrete to a fall of not less than $2\frac{1}{2}$ inches to 10 feet, with ventilated inspection pits at every bend, and an intercepting chamber as close as possible to the junction with the street-sewer.

The stack-pipes should be of galvanised cast iron, with socketted and caulked joints, connected directly with the drains, and continued some 7 feet above the roof as ventilators. These may be made to serve also as rain-water pipes, by means of a species of movable ventilated bell-trap, and are available for flushing the drains when the water-tanks are emptied.

The w.c. apparatus, which may be a Bristol glazed flush-out closet with water-waste preventing cistern, should have specially cast iron Y connections with the stack-pipes that there may be no joints in the thickness of the wall. The stoneware sinks may be fitted with $1\frac{3}{4}$-inch glazed waste-pipes, with syphon traps and inspection inlets, discharging outside the building by a stack-pipe above the water line of a yard gulley-trap.

All the water-mains should be of galvanised wrought-iron pipe, and stop-cocks should be provided for shutting off the water from each separate tenement in the event of repairs being required.

Fire Hydrants.

Fire hydrants should be provided at intervals in the courtyards; they would be found useful for watering and cleansing the courtyards as well as for the extinction of fire.

Cost of Land and Buildings.

Details of cost are not easily obtainable, nor are the figures of executed schemes unfailing guides for the future.

Some undertakings owe their remunerative returns to the liberality of a ground landlord who has leased a site below its market value, as in the case on Lord Portman's estate in Lisson Grove, and on the Duke of Westminster's estate in Oxford Street. A marked contrast presents itself in the case of the Petticoat Square site, where the land cost the Commissioners of Sewers at the rate of £14 per square yard, including trade compensation to tenants for disturbance.

Mr. Moore, of the Improved Industrial Dwellings Company, calculates the average amount paid for freehold land by his company to be about 30s. per yard, the highest they have paid being £2 14s. 4½d. Mr. Moore calculates the present cost per room to be about £60, including w.c.'s, laundries, &c., the average weekly rent per room being now 2s. 1¼d.

Tenant Proprietorship.

In view of the increasing political power and wage-earning capacity of the working classes, I venture to urge consideration of the question of tenant proprietorship. I believe myself right in saying that facilities for purchase have largely been taken advantage of by artisans in many towns in the North of England, where the encouragement of thrift, sobriety, and self-respect has been eminently beneficial to the tenants.

So important is this matter considered in France, that the "National Association for the study of questions relating to the improvement and construction of cheap dwellings," which is an outcome of the International Congress held in Paris during the Exhibition of last year, has devoted the whole of its first publication to details of a scheme adopted in Havre for giving facilities to artisans for the purchase of four-roomed cottages in their own walled gardens, by quarterly payments extending over 14 years, and amounting to 10 per cent. on the purchase money paid annually.

The chief distinguishing feature consists in the fact that when one-third the purchase money has been deposited, a conditional deed of conveyance is granted, which is saleable, and

this constitutes a marked departure from the lines of most of the Building Societies in our own country.

In London an association has recently been established under the auspices of the officers of the Leman Street Co-operative Wholesale Society, from the prospectus of which I quote the following:—

"The Society was formed in 1888 with the object of applying to the owning and letting of working men's dwellings the principle of co-operation, which has proved so successful when applied to retail distribution.

"Fair rents, according to the current rates of the locality, are charged to the tenants, who must be members of the Society. After making proper provision for expenses, &c., a dividend, limited to 4 per cent., is paid on the share capital, and the remainder of the profits are divided amongst the tenants in proportion to the rents paid by them, and when so divided are carried to the credit of each tenant's share account until he has so much capital in the Society as is equivalent to the value of the building inhabited by him. After such a period has been reached, the dwelling occupied by the tenant will remain the property of the Society, but he will be entitled to receive his share of surplus profit in cash.

"When a shareholder ceases to be a tenant, the Society will have the right at any time to purchase and extinguish his shares; but in the event of the Society being unwilling to exercise this right, the shareholder will have the usual power of selling them."

The rules provide that internal repairs shall be done when the Society deems necessary, and, unless carried out by the tenant of the repaired building, they will be charged against his share account.

Each estate is to be managed by a committee of tenants, and it will be to the interest of every member of the Society to find a tenant for an empty dwelling, as well as to see that his fellow members are careful with the Society's property and pay their rent punctually.

The advantages offered are, a share in the increased value of the real property of the Metropolis caused by the growth of population; an attractive and profitable mode of investing savings, an economy of rent, and the prospect of becoming capitalists.

It is too soon yet to judge of the success of the scheme, but the Society has already two small properties in full occupation, the one at Upton Park, the other at Penge. Am I unreasonable in suggesting the possibility of a scheme for appropriating to the erection of dwellings, in the form of loans,

some part of the rapidly-increasing resources of the Post Office Savings Bank, by affording facilities to depositors to convert their savings into shares, and thus extending the interest of artisans in a commercial enterprise of the greatest social value?

Summary.

I have to express my thanks for your indulgent attention, and in conclusion, would summarise my observations as follows:—

1. That artisans' tenement dwellings need most careful planning and construction, to secure the healthfulness and moral welfare of the tenants.

2. That, in the interests of the artisan class, and for the relief of the congestion of our central districts, increased facilities should be afforded for residence in the outskirts by reorganised train-services at low fares.

3. That tenant proprietorship, which has elsewhere proved a boon to artisans, should be encouraged by all equitable means in the neighbourhood of London.

These remarks I commend to the earnest consideration of all those who have at heart the health and welfare of our artisans and labourers and their families, and especially to the members of The Sanitary Institute.

Mr. E. C. Robins (London) observed that the plans prepared by Mr. Hooper showed great improvements in modern industrial dwellings. One thing especially was important, and that was the private manner in which the buildings ought to be constructed. He objected to their looking like workhouses or warehouses, and pointed out that many people did not like to be associated with anything that looked like charity. In the dwellings over which he had some supervision he found there was a demand for separate water-closets, but this was an expensive arrangement, and perhaps the best thing to do was to give these closets a separate access. In cases where the houses had flat roofs some were used for the purpose of washing clothes, whilst others became drying-grounds, and some play-grounds. But they found that the inmates did not care about the wash-house being thus situated though they did not at all mind the roof being used as a drying-ground.

Mr. H. H. Collins (London) said with regard to a point raised by Mr. Robins that he thought, do what they would, this question of industrial dwellings must become one of charity. They could not then look like palaces, and if people wanted cheapness they must be content with a very small return for their outlay. The first question was that

of land. Artisans wanted to live in good neighbourhoods but did not care to pay the additional cost, forgetful or ignorant of the fact that when owners had to pay more than twopence per foot for land, it was impossible to secure the accommodation they wanted for two shillings a room. He disapproved of sculleries, closets, or corridors being in common. He found it cost him no less than £50 for each room of measurements something like $12 \times 14 \times 10$. However, instead of the artisan using them he found they became occupied by clerks and their families, so that their end was very different from what was intended. Then the rooms had to be of sufficient height—8 feet had been mentioned as the minimum—and he held in addition they should be fire-proof.

Dr. Sykes (London) spoke from his experience as a member of the Council of the National Dwellings Society, and held that the last block of artisans' dwellings that had been erected, that in Waterloo Square, Camberwell, was the very finest. The question was largely one of cost, and he thought instead of calling them artisans' dwellings, they would be more accurately described as dwellings at 2s. 6d. per week, or block dwellings, so as to distinguish them from ordinary private houses. Recently he had had occasion to enter into some research, concerning the number of persons that could be housed on a given space. Much depended of course on the conditions, one of the first of which was the width of the front and back space. The angle of incidence of light should be at least 45 deg. One of the chief things to be considered was economising space. In the Peabody system they got about four-fifths of their properties for dwelling purposes and the other fifth for access and accessories. With regard to sleeping and living-rooms, the usual amount of space was 300 feet per person for living-rooms, and 400 for sleeping and living when combined. This, he considered was not sufficient. Instead of 300 or 400 it ought to be 700 feet for each person. Whilst he recognised the necessity of providing wash-houses, coppers, coal-sheds and sinks, he thought that baths in industrial dwellings were a great mistake. He had found that the baths became blocked up with various items of furniture and were never used. The people did not like them, and he supposed a reason might be found in the fact that there was no hot water. If baths were to be adopted at all, he suggested that they should be erected in separate buildings fitted with hot-water pipes, and be placed under the charge of an attendant. He objected to any artificial systems of drainage or ventilation, for the people did not understand any but the simplest constructions and all others became speedily out of order. As to the question of charity, he did not know of any rooms that could be let for one shilling or one shilling and sixpence per week. The least he thought they could let single rooms for was two shillings and sixpence per week. In common lodging houses in London, the lowest charge was fourpence per night or two shillings and fourpence per week, and yet the County Council were thinking of exercising their charity (in spite of the Industrial Dwellings which were let, as he had shown, cheaper) by erecting a

number of these houses. In his experience Industrial Dwellings could not be erected under £56 a room, and it was absurd therefore to think of letting them under two shillings and sixpence a week. With regard to the question of common closets, common corridors, and common things generally, these were the amenities of social communities living together, and the improvement that was wanted must come he thought from the manners of the people themselves.

Mr. WILLIAM WHITE (London) had been asked to suggest that there should be a mortuary attached to Industrial Dwellings, and also that it would be a great advantage if provision could be made for gas stoves. With regard to ventilation he thought a flue should be constructed with openings near the ceiling, so as to ensure the circulation of air.

Mr. HOOPER (London), in reply, said that he had alluded in his paper to the dwellings in Glasgow, where provision was made for single room tenants. Recesses were made for the bed, the room was well ventilated, and it had a closet with sink and fuel stove and cooking implements.

The PRESIDENT of the Section pointed out, that if they made Industrial Buildings so perfect as to render them expensive, many artisans would prefer the cheaper dwellings that were already in existence.

SECTION III.

CHEMISTRY, METEOROLOGY, AND GEOLOGY.

ADDRESS

BY W. TOPLEY, F.R.S., F.G.S., ASSOC.M.INST.C.E.,
Geological Survey of England.

PRESIDENT OF THE SECTION.

"*Geology in its relation to Hygiene.*"*

IT is possible that the remarks which I wish to make in opening this Section may be considered by some to be rather out of place at a meeting of this Institute; some may think them too special and technical; but the subjects admitted to Section III. are so extensive that specialisation on the part of its President is to some extent a necessity, and I think further that a man is best occupied when speaking on a subject which he knows fairly well.

It may be that by taking a special district as our text we can well illustrate some general principles; and at the same time a description of the district in which we are now meeting may not be without interest to some now visiting it.

The geology and scenery of Sussex may be considered somewhat tame and uninteresting to those who arrive here from the wilder and more mountainous districts of the North and West; yet for many reasons Sussex is peculiarly well suited for illustrating the subject before us. The varieties of soil are here strongly marked—clay, sand, and limestone being each well developed. The conditions under which springs and under-

* The various points referred to in this Address were illustrated by numerous Diagrams, including the Maps, Sections, &c., published by the Geological Survey. Information relating to the geological structure of the district will be found in the author's "Geology of the Weald" (*Memoirs of the Geological Survey*), 1875. Reference may also be made to a paper on the "Agricultural Geology of the Weald," in "Journ. R. Agric. Soc.," Ser. 2, vol. viii., p. 241, 1872.